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GEO. H. FROST, PROPRIETOR.

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LAST Wednesday, at the works of Norman Hubbard, Brooklyn, we examined a nearly completed duplex pump, made in accordance with patents issued to A. E. Hall, of Plainfield, N. J. Instead of rocker-arms, by which the parts of one cylinder are opened by the movement of the opposite piston-rod, an arm projects from the center of each piston-rod and operates an ordinary D valve in the steam-chests, which are above the cylinders. The steam passes from one steam-chest to the opposite cylinder through core holes in the castings. To prevent all pounding, as the piston-head nearly reaches the end of its stroke, a small valve is opened and live steam admitted in front of the piston, thus forming a most effectual cushion. The pump will be so adjusted that there will be no pause at the end of the stroke, and the two pistons will move continuously —one being one-half stroke in the rear of the other. As soon as finished the pump will be accurately tested.

THE HUDSON RIVER TUNNEL.

As the Hudson River Tunnel is probably the grandest engineering enterprise now in course of execution, its progress deserves close watching. We have from time to time followed developments, and as important modifications in detail have been made and are in contemplation, a brief review of what is being done may be of interest. When, some time since, Gen. W. Sooy Smith and son took charge of the work, progress was being made in the south tunnel by means of a "pilot tunnel," a temporary advance heading which offered the advantages of affording a support to the iron work and to the ground above during the course of its erection. Nevertheless, there was trouble in maintaining the grade, and the tunnel was therefore being run deeper than it was originally projected. Gen. Smith holds this to be due to several causes, and he has changed the plans in accordance with his views.

Formerly the pilot tunnel was not kept in a central position, it being driven in the upper part of the section in order to give more room for work below. The bracing was irregular and was not, therefore, capable of giving the full support it might be made to yield. The pilot itself was not rigid enough, and therefore the iron of which it is made is being strengthened, and the flanges are made thicker. Gen. Smith holds that it is thus in a better condition to resist the strain with which it is taxed, and the tunnel is safer and under better control.

The silt is dug away in the usual manner, but much care is exercised in always protecting the face against any movement of the ground by temporary bulk-heads, well braced. An additional cause for the irregularity of the work, besides the lack of rigidity of the work, has been that when laying the iron rings hollow spaces were left outside of them, and as soon as the weight of the masonry was on them they sank, thus throwing the tunnel out of grade, and causing the formation of cracks in the finished work. By ramming in concrete, and forcing each plate into position, this tendency is now lessened. It has been found possible with these improvements to keep the grade firmly, and it is expected that it will be soon possible to control it absolutely. At present the tunnel is being run longitudinally, in order to regain the ground lost formerly.

The system of removing the silt, too, has been modified. Formerly the silt was blown out by means of compressed air alone; a system of which Gen. Smith claims to be the inventor, having used it before the war and patented it in 1866.

The use of compressed air alone was found to be insufficient on account of the length of horizontal pipe through which the silt had to be carried, and now an Eads' sand pump is used for the purpose. Its suction pipe enters a box provided with a buffer. The silt is spread over a wire screen at the bottom of the latter, and, mixed with water, is discharged directly into the open air, thus doing away with the conveyance of the silt to the connecting chamber on cars, as practiced before. The water and compressed air together dispose of the silt effectually, and it can be delivered much faster than it can be supplied at the present rate of excavation, nor is it expected that it will be taxed to full capacity in the future. Under other conditions Gen. Smith has removed one cubic yard of sand per minute by this process. This modification in the method of removing the material has made it possible to employ a larger number of men in the other work, and the rate of advance is now controlled by other considerations than by the work of excavation.

With a view to rendering the tunnel more rigid, the iron rings will probably be strengthened. The method of lining, too, has been changed. The lower half of the tunnel, which soon after its completion is filled with silt, is made of solid concrete. The upper half is at present lined with a 5-inch course of asphalt blocks, backed with brick-work. It is, however, the intention to have three courses of concrete blocks and a lining of asphalt blocks, all $6 \times 6 \times 16$ inches. This construction will admit of more rapid work, so that the lining can follow excavation promptly, if the rate of the latter is increased. The lining, too, is impervious to compressed air, so that no leakage can take place during the work, and at the same time it is stronger than the brick-work used hitherto.

A further change has been made by placing new air-locks in the tunnels themselves. At a distance of 430 ft. from the shaft a bulk-head of 4-ft. masonry and timber, well braced, has been placed in both the north and the south tunnels, which are 450 and 475 ft. out, respectively. In the upper half of the bulk-heads are two air-locks equal in size to the large air-lock in the main shaft. This insures greater safety and at the same time makes the maintenance of compressed air necessary in only a small part of the work, the rest of the completed tunnel and the connecting chamber being thrown open to atmospheric pressure as soon as it has been proven that that portion of the work is tight. When the tunnels have advanced for a distance to be determined by future experience, a new lock near the end will be put into each tunnel, superseding the old one and thus forming a new base of operations. At present the pressure in the tunnel varies from 20 to 23 lbs., and in order to regulate it close watch is kept of the small bubbles of air which appear in the river occasionally.

On the New York side, at the foot of Morton street, work has been actively begun by the construction of a caisson by which the tunnel level will be reached. The plan of sinking a shaft, as was done on the New Jersey side, will not be followed. The dimensions of the caisson are, approximately, 46×34 ft., the largest air chamber ever built.

DRAINAGE OF THE TWENTY-THIRD AND TWENTY-FOURTH WARDS, THIS CITY.

To the Board of Commissioners of the Department of Public Parks:

In accordance with the resolution of the board, I have the honor to submit the following report upon the drainage of the Twenty-third and Twenty-fourth wards of the city of New York.

The main uses of drainage are threefold:

1. For agricultural purposes;
2. For construction purposes; and
3. For purposes of health.

The beneficial results of drainage in connection with agriculture are so constantly and directly demonstrated, that at this day they are generally clearly understood and appreciated. Drainage not only adds to the fertility of land already under cultivation but renders susceptible of cultivation that which would otherwise be useless.

Again, no one will dispute the fact that it is impossible to erect a solid structure, or to build a firm roadway, on wet, undrained foundations.

The relationship of drainage to health is, however, much more intricate, and hence less clearly understood. It is evidently the single subject intended to be considered in this report. The value of land in the Twenty-third and Twenty-fourth wards for farming purposes will be continually decreasing, compared with that of its use for building. It is estimated that in these two wards not more than 2,000 acres, or 16 per cent. of their aggregate area, are now worked as farms.

The more consideration is given to this subject of drainage for health, the more it is found to comprehend, and the greater the difficulty becomes in condensing the subject sufficiently for the purposes of this report. I shall make use of the term drainage in its restricted meaning—that is, the removal by means of open or covered permeable channels, called drains, of surface or soil saturation water, where its presence would be detrimental to animal or vegetable life. It must not be confounded with the term sewerage, which expresses the carrying off by means of water-tight conduits, called sewers, of the waste matters, liquid or solid, organic or inorganic, connected with domestic or human economy and the arts. Sewage is the general term for the substance removed through sewers. It consists principally of he fluid and feculent refuse of dwellings.

I propose to consider the subject on which this report is directed to be be made: First, by giving a description of the region under consideration, from all points of view bearing on the subject of its drainage; second, by sketching, as briefly as possible, the more commonly accepted theories of malaria and of drainage and sewerage; and third, while keeping in view the preceding two parts, by making certain practical suggestions and recommendations looking to the drainage and improved sanitary condition of the district.

I.—GENERAL DESCRIPTION.

The district under consideration comprises about 12,317 acres lying on the north and east of that portion of Manhattan Island above One Hundred and Twenty-seventh street, and immediately south of the city of Yonkers.

Its northernmost point, Mount St. Vincent, is about 15 miles from the City Hall, and the southernmost, North New York, about 7½ miles; Hunt's Point, its easternmost limit, touches a meridian 7¼ miles east of that passing through the City Hall, while Spuyten Duyvil, its westernmost point, is about 4¼ miles east of the same meridian. Roughly stated, it is 7½ miles long by 3 miles in width. Beginning at the north and taken successively its boundaries are as follows: An arbitrary straight line, the southern line of the city of Yonkers, extending southeasterly from the Hudson River at Mount St. Vincent to the Bronx River, at the junction of the Harlem and New Haven railroads; thence southerly along the Bronx River to Long Island Sound, at Hunter's Point; thence westerly, following Long Island Sound to Port Morris; thence northwesterly, along the Bronx Kills to the Harlem River at Mott Haven; thence northerly and northeasterly along the Harlem River to Kingsbridge; thence westerly to the Hudson River, along the Spuyten Duyvil Creek; thence,

finally, northeasterly along the Hudson River back to Mount St. Vincent; in all about 23 miles long.

Approximately :	2.5	miles	on the	Hudson River,
"	6.5	"	"	Spuyten Duyvil & Harlem River,
"	1.0	"	"	Bronx Kills,
"	3.0	"	"	L. I. Sound,
"	7.0	"	"	Bronx River.
	20.0			Total of water boundary.
"	3.0	"	"	South boundary of Yonkers.
"	23.0	miles in all.		

Along the Bronx there are 2.5 miles of salt and 4.5 miles of fresh water.

That is, some 67 per cent. of the boundary consists of large tidal water courses—20 per cent. along a fresh water course of considerable flow, while only 13 per cent. is a land boundary.

Topographically described, the district consists of three promontories or ridges, decreasing successively in elevation from west to east. Beginning at the west, we have

1. The Spuyten Duyvil promontory, included between the Hudson River and Tibbetts Brook ;

2. The Fordam Heights' ridge, included between the Tibbetts Brook and its extension, the Harlem River valley, and the Mill Brook valley;

3. The ridge between the line of the N. Y. & Harlem R. R. and the Bronx River and Long Island Sound; its western slope being generally much more marked than its eastern.

The axes of these ridges are parallel with the palisades on the west side of the Hudson and have a direction N. N. E.

Transversely a series of rock waves succeed each other, with crests successively diminishing in height from west to east. A section passing from the Hudson to the Bronx will best illustrate this—Fig. 1.

Minor ridges parallel with the main ones subdivide the main valleys into smaller valleys and water sheds, each drained by some well marked stream. These and the main streams, enumerated successively from west to east, would be as follows:

1. The Hudson River.
2. Tibbets Brook and Harlem River.
3. Cromwell's Creek, } Mill Brook
4. Ice Pond Brook, } Main Valley.
5. Mill Brook. }
6. Bungay Creek,
7. Bound Brook and Legget's Creek, } Bronx River Main Valley.
8. The Bronx River. }

The course of these streams is generally direct, and may be stated as from 20 to 30 degrees east of north ; their inclination slight and comparatively uniform—their flow uninterrupted though variable.

Thus the lines of main drainage are direct and clearly indicated by nature. These streams are so large, and any obstruction of their channels will be so immediately apparent, the cause and effect so direct, that there is but little danger of their being neglected for any length of time.

The more difficult problems in the drainage of the district under consideration are in connection with a class of streams smaller than those mentioned above, and more or less intermittent in their flow.

Roughly stated, their general direction may be said to be at right angles to that of the preceding class, of which they are feeders. But their course is much more interrupted and indirect, and their average inclination much greater and less uniform.

As stated, these secondary streams are at right angles to the main streams, or valleys ; hence in flowing towards them they cross successively rock ridges and pockets. Their water first fills these pockets to the level of the lowest point of the lower ridge before commencing to flow off. If nature has filled in these pockets with drift to a height of several feet above the lowest point of the inclosing ridges, no harm need be apprehended, as the rainfall will be easily disposed of—about 55 per cent. being evaporated, or flowing directly over the surface to the streams. The rest will be absorbed by the ground—a portion sinking, or subsiding, to the level of the lowest point of the inclosing ridges to maintain the saturation of the earth in the pocket, while the greater part will move, or percolate through the ground with a slow, uniform velocity, to the water-courses or springs.*

On the other hand, if these pockets have become gradually filled up by sedimentary deposits and the remains of vegetable growth instead of drift, the surface will be found almost level, and about at the elevation of the lowest point of the inclosing rock ridge. This last condition is almost without exception malarious.

The geological structure of a country is intimately connected with its drainage.

The nature and kind of rock have a marked relationship to the amount of water retained after each rainfall, and afterward gradually given off, principally in the way of springs.

Thus, in a limestone region springs will be fewer and more important than where the rock is harder and without regular stratification, as granite, trap, etc.

In the comparatively soft limestone, water percolating through the fissures gradually enlarges them into subterranean channels, sometimes of great size.

Where sedimentary rock lies, as deposited, in undisturbed strata, we should not expect to find swamps due to rock pockets.

Where the strata are nearly horizontal and unbroken but dished, that is, cropping out at the edges, we may be pretty certain than an artesian well can be sunk which will furnish an abundance of water.

Where the rock is of a non-absorbent character —like trap—the small streams will be intermittent in their flow, becoming little torrents after storms, and generally drying up in summer.

If the surface is composed of deposits of the quarternary system other than alluvial, we very frequently find numerous basins of no great extent—doubtless due to eddies in the original deposit-bearing currents. Should the adjoining higher ground contain clay, or rock with iron in its composition, these basins become more or less lined with hard pan, and consequently water-tight, thus creating swamps, ponds, etc. Where these small water-tight basins overlie a pervious stratum, like sand for instance, as is often the case, advantage may sometimes be taken of the fact, in order to effect drainage, by simply piercing through the hard pan and allowing the water to drain down into the sand.

Where feldspar has become decomposed, forming what is known as kaolin, we can always expect to find malaria ; the kaolin acts like puddle, preventing the passage of water. When mingled with certain forms of iron a strong kind of cement results, which is likewise impenetrable by water, but falls to pieces on exposure to oxygen.

Again, a study of the geological formation of any region not only suggests where drainage is likely to be needed, but the proper methods of effecting such drainage with the greatest economy. For instance, in a district with outcropping parallel ledges we should expect to find swamps in the depressions between the ledges. The proper system to effect drainage would be to cut through these ledges. In what direction this cut should be made, in order to be the shortest, would be at once suggested by a knowledge of the position of the axes of these ledges. Where a slope is found wet and boggy, geology teaches us that some impervious stratum opens on the upper part, and that the cheapest way to drain such slope is not by any ramified systems of drains extending in all directions, but simply by one intercepting drain, cut along the slope just above the impervious stratum where it would tap the water-bearing superstratum, thereby carrying off the water before it has an opportunity to leach out on the surface of the slope.

The geological formation of the Twenty-third and Twenty-fourth wards is both of the oldest and the most recent. Most of the western portion consists of rocks of the primary system ; some, and perhaps all, were in existence at the close of the Azoic time, while much of the eastern portion, as Hunt's Point and Port Morris, is still in process of formation, and belongs to what is known as the quarternary system.

All rocks here found in place, with possibly one exception, are of the primary system and of indefinite age, while the boulders, earth, sand, etc., covering this rock belong to the quarternary system. The primary rocks found in place are principally gneiss or granite, the former largely predominating.

Gneiss is so-called metamorphic rock; that is, it has been metamorphosed or changed from its original character, probably by great and long-continued heat. Its component materials—quartz, feldspar and mica, or else hornblend—are the same as those of granite, yet stratified, and more or less crystalline, while granite is thoroughly crystalline and unstratified; consequently, gneiss is a better water-bearing rock than granite, and will furnish more steady drainage, yet it is not so pervious as to prevent its streams partaking of the character of torrents. The gneiss of this region is what is called micaceous; that is, it contains a large proportion of mica, a small proportion of quartz, and still less of feldspar, but generally an abundance of iron pyrites in very minute crystals, which on exposure are decomposed—the iron remaining in the form of rust gives a permanent ferruginous cast to the rock.*

These primary rocks have been greatly displaced from the position in which they were originally deposited, so that the strata are nearly vertical, differing no more than ten degrees from the same. As a consequence, the rain falling over any such locality is its sole water supply, hence in this region there is no probability of the success of so-called artesian wells. This vertical stratification is an additional cause, to that of the absorbent nature of the rock already noted, for the numerous small and inconstant springs in its vicinity.

The one possible exception, referred to before, where the rock of this district is not primary, is that of the certain outcrop known as Kingsbridge or Westchester marble, or dolomite. It is a coarsely crystallized, compact limestone, varying in hardness from a good, strong building stone, almost impervious to water, to a stone that may be crushed in the hand, and will absorb from 3 to 7 per cent. of water.† Wherever found it ranges about N. N. E. It crops out at Kingsbridge, Mott Haven, Melrose and Tremont.

The conclusion has been arrived at, by high authority, that this dolomite was originally the same formation as that now known elsewhere as Mohawk limestone, and that the associated gneiss, etc., were originally the same that are now known as Potsdam sandstone and Hudson River slate, metamorphosed to their present condition from having been subjected to great heat and pressure.

The quarternary system is comparatively recent, and hence its history comparatively easy to unfold. It overlies most of the primary rock in the annexed district, increasing in thickness from west to east. It consists of the débris of older formations, and the vegetable accretions forming above the same. The former in shape of earth, sand, gravel and boulders of all varieties of minerals, the drift of former mighty polar currents; the latter in the shape of earth, mould, peat, mud, salt meadow, etc.

The quarternary system has been subdivided in the Geological Survey of New York State, into :

1. The Alluvial Division,
2. The Quarternary Division,
3. The Drift Division.

Where all three are found superimposed, their order from the surface downward would be as above. The drift was first deposited in the shape of sand, boulders, etc., then the quarternary in alternate layers of clay, sand and gravel, deposited from comparatively quiet waters, then in succession the alluvial division, now forming in the shape of marl, peat, soil, sand, etc. Sand is in by far the greatest proportion, as it is the result of the constant disintegration of silicious rock. This disintegration is due to chemical and mechanical causes, cold and heat being the principal ones.

In some cases the gneiss and granite are found—generally at the bottom of wet pockets—in a disintegrated state, so soft as to be readily removed by pick and shovel, owing to the decomposition of the feldspar and iron pyrites. This soft rock is very retentive of water.

From even the foregoing superficial examination of the geological character of the annexed district, we can predicate its hydrological features.

But little of the rainfall will be absorbed and retained by the rock.‡

The rock is bare in many hills, and in many places has but a thin covering of soil.

Its strata have been much disturbed, so as now to be nearly vertical, cropping out in numerous parallel ledges. These are not continuous, but *en echelon*. Between them are deep valleys or ravines which have been partly filled with drift. The elevation of those ledges is almost always considerable, giving steep inclination to the hill-sides.

Consequently, the greater part of the rainfall

* I apprehend that no unhealthfulness is due to water in itself in motion, whether flowing over the surface or through the ground. The danger arises from that portion which remains stagnant, either above or under the ground. The south side of Long Island is a notable instance of a remarkably salubrious region, where water is found in abundance but little below the surface. That this water is, however, steady in motion has been clearly proved. The surface of the ground water is found to be an inclined plane rising uniformly as it recedes from the sea.

*Mather.

† From experiments by Sidney W. Hoag, Jr., Assistant Engineer, D. P. P.

‡ Prof. Newbury found that specimens of serpentine from Staten Island absorbed from 13 to 28 per cent. of water: sandstone from Amherst, Ohio, 6¼ per cent.; limestone from Athens, Ill., less than 2 per cent.

passes off very quickly. The streams transverse to the valley axes partake, more or less, of the character of torrents, excessive in flow immediately after and during storms, yet quickly drying up.

transverse streams. They become quite low in summer, yet the difference between their flow in wet and dry seasons is comparatively less than that of these feeders.

Where the formation is of the quarternary

At present there are but few manufacturing establishments in the Twenty-third and Twenty-fourth wards. This condition cannot continue long. In fact there is but little doubt that they will receive in time a greater amount of manu-

	Location of Outlet.	Approximate length.	Fed by	Remarks.
	Hudson River Water Shed.			
1	Near Randolph's lane	1,000 feet		Dry in summer; partly a covered drain.
2	Near north line Schermerhorn estate	1,000 feet	Springs	Stony bed.
	Between Schermerhorn estate and property of D. W. James	1,800 feet	Springs	400 feet covered drain, stony bed.
	About 500 ft. north of Delafield's lane	1,600 feet	Springs	More or less walled, and converted into open drain; divides into two streams about 1,600 feet from river; north branch, 1,000 feet; south branch, 600 feet; sluggish.
	On Delafield property	1,500 feet	Springs	Dry in summer; 300 feet of open drain; upper portion sluggish; about 300 feet of middle portion stony.
	On Whiting property	1,600 feet	Springs	Dry in summer; two parts; stony bed lower end.
	Spuyten Duyvil Creek Water Shed.			
1	On Cox estate	1,400 feet	Springs	Dry in summer; rocky and stony bottom at upper portion, polluted near mouth.
	Tibbet's Brook Water Shed.			
1	East side, about 200 ft. north of Mohalu avenue	2,500 feet	Extensive swamp	Dry in drouths; generally stony bed; sluggish near Jerome avenue.
2	East side, about 2,000 ft. south of preceding	1,500 feet	Springs; possibly receives leakage from aqueduct	Quite small; upper end stony, lower portion sandy.
3	East side, about 1,400 ft. south of preceding	1,500 feet	Springs, drain and swamps	Upper end sluggish, lower end sandy.
4	West side, 1,000 ft. north of Van Courtlandt Mansion	15,000 feet (with branches)	Springs, swamps and principally drains	Principal feeder of Tibbet's Brook; about 6,000 feet of lower end sluggish; upper portion generally stony bed.
5	East side, along Gunhill road	2,500 feet	Springs principally	Small; dry in summer; upper end 500 feet muddy, middle portion stony, lower end muddy.
6	West side, opposite land of B. Dash	3,000 feet	Swamp and springs	Small; dry in summer; lower portion sandy and swampy, middle portion stony.
7	East side, near Van Courtlandt avenue	4,500 feet	Springs and drain	Supplies rolling mill at Spuyten Duyvil with water; sluggish at upper end for 2,000 feet, then 1,500 feet stony, then 1,000 feet sandy and swampy.
8	West side, on land of W. Hutchins	500 feet	Spring	Stony bed.
9	East side, between lands of Shrady and Giles	3,000 feet	Principally ditches, some spr'gs	Upper portion very sluggish, with muddy bottom; between Albany and Boston avenues stony; mouth in salt meadow.
10	West side, on Ewen property	1,000 feet	Swamp	Dry in summer; upper end sluggish for 600 feet, rest generally rocky and stony.
	Harlem River Water Shed.			
1	Just south of Farmer's Bridge	1,500 feet (with branch)	Springs	Flow of upper portion good, lower end sluggish.
2	Just north of Fordham Landing road	7,000 feet	Natural and artificial drainage	Converted into covered drain in places, upper end artificial in Jerome Park.
3	South of Fordham Landing road	600 feet	Spring	Stony bed at upper end, then sandy; muddy at mouth.
4	About 600 ft. north of Morris Dock	2,000 feet	Springs	Partly open drain, generally rocky or stony.
5	North side of Wolf street	1,800 feet	Drainage principally	Stony bed, partly covered.
	Cromwell's Creek Water Shed	17,000 feet		About one-third of length salt water, and about one-third open or covered drains.
1	Between Burnside and Cameron streets from the east	2,500 feet (inc. both branches)	Drainage principally	Upper portion, west of Jerome avenue, sluggish; carried along Jerome avenue as covered drain; east branch rocky.
2	West side, opposite Tremont avenue	1,200 feet	Swamps; possibly some leakage from aqueduct	Sluggish; muddy bottom.
3	West side, on L. G. Morris' property	600 feet	Swamp	Lower end rocky bed.
4	East side, on north line Townsend Poole property	2,000 feet	Swamps and springs	Ditched in many places; sluggish.
5	West side, upper end Goble's pond	1,000 feet	Natural drainage	Rapid descent for lower part, upper end sluggish.
6	West side, just south of boundary between 23d and 24th Wards	2,000 feet	Drainage of swamps on Ogden estate	Sluggish at upper end, steep at lower end; stony, rocky bed.
7	East side, about opposite preceding	1,500 feet	Natural drainage	Upper portion sluggish, lower portion sandy bed
8	West side, on Anderson property	1,500 feet	Natural drainage and springs	Lower end rock bed, upper end sluggish.
	Ice Pond Brook Water Shed	6,800 feet	Swamps	Sluggish throughout, lower portion polluted
	Mill Brook Water Shed	6 miles	Swamps and branches	
1	East side, near Jerome avenue	1,600 feet	Swamps	Sluggish.
2	West side, near Potter place	3,000 feet	Swamps and drainage	Partly drains Jerome Park; descent generally good.
3	East side, 500 ft. north Jerome Park Station	1,500 feet	Swamps and springs	Sluggish.
4	West side, 300 ft. north of Isaac street	1,500 feet	Pond and spring	Lower 500 feet sluggish flow, above that stony bed.
5	West side, 300 ft. south of John street	1,000 feet	Springs	Upper portion sluggish, partly covered, polluted from houses on its course.
6	West side, north of Fordham Schoolhouse	2,100 feet	Ponds and ditches	Partly converted into covered drain; lower portion stony bed, upper portion sluggish.
7	East side, about 185th street	2,000 feet	Principally drainage from Fordham avenue	Dry in summer.
8	West side, between 178th and 170th streets	4,000 feet (with branch)	Natural and artificial drainage and springs	Outlet converted into covered drain, upper portion muddy bottom, middle portion stony bed.
9	East side 175th street	5,300 feet (with branch)	Drainage, natural and artificial	About 1,000 feet of lower end converted into sewer; also covered at several other points; upper end sluggish, with muddy bed.
10	West side Fleetwood Park	5,200 feet	Swamps	Upper end open ditch; sluggish.
	Bungay Creek Water Shed	7,800 feet		
1	East side Clifton street	1,200 feet	Drainage	Portions converted into open and covered drains; dry in summer; very sluggish.
2	West side, about Dawson street	1,000 feet	Drainage	Partly converted into covered drains; dry in summer; sluggish.
	Leggett's Creek Water Shed.			
	Main stream	2½ miles		Tide water for about half a mile above mouth.
1	West side Prospect avenue	700 feet	Swamps	Dry in seasons of drouth.
2	East side Freeman street	3,500 feet	Swamps principally	Lower end covered drain.
3	West side, just north of Home street	3,000 feet (with branches)	Swamps, natural drainage and springs	Sluggish; covered in one or two places on branches.
4	East side, opposite last	1,500 feet	Natural drainage	Flow good; dammed for ice in winter.
5	East side, at Fox street	800 feet	Drainage, natural and artificial	Sluggish current.
	Bronx River Water Shed.			
	Main stream	7 miles within city limits	Lakes	2.5 miles of salt water.
1	West side, at Harlem Railroad bridge, north of Woodlawn	1,000 feet	Natural drainage and springs	Upper portion sluggish, with muddy bottom; middle portion good flow; stony bottom.
2	West side, just south of Woodlawn station	12,000 feet (with branch); 7,000 feet of above in Yonkers	Swamps, pond and drainage, natural and artificial	Upper portion sluggish; through Woodlawn Cemetery rapid descent.
3	West side, center Woodlawn Cemetery	3,000 feet	Swamps and artificial drainage	Upper portion sluggish for about 2,500 feet; rest of distance rapid; stony bed.
4	West side, just north of Katonah street	4,500 feet (with branch)	Swamps and natural drainage	Generally sluggish, with muddy bottom; about 700 feet at lower end rapid fall, stony bed.
5	West side, at William's Bridge station	1,000 feet	Spring	Part covered drain; descent rapid.
6	West side, about Mallow street swamp	1,200 feet	Swamp	Muddy bottom.
7	West side, just north of Pelham avenue	1,000 feet	Springs and natural drainage	Muddy bottom.
8	West side, just south of Pelham avenue	8,200 feet (with branches)	Artificial drainage	Sandy bottom in drains; lower end rapid fall.
9	West side, about 500 ft. above tape factory	2,000 feet	Swampy land	Sluggish flow.
10	West side, at morocco factory	6,000 feet (with branch)	Swamps and drains	Very sluggish; generally muddy bottom.
11	West side, at gas works	1,000 feet	Natural drainage	Partly covered; dry in seasons of drouth.
12	West side, just above Harlem River and P. C. R. R. bridge	1,000 feet	"	Covered for about 200 feet; dry in summer.
13	West side, on Hoe property	1,000 feet	Drainage and sewerage	Sluggish; lower portion through salt meadow.
14	West side, 1,000 ft. south of preceding	800 feet	Spring	Unimportant.

The springs are numerous, but small and inconstant.

The main valleys parallel with the ridges are comparatively level. The main streams occupying the valleys are much more sluggish in flow and uniform in inclination than their feeders, the system, as in the southeastern portion of the district, the valleys are less clearly defined, and the streams partake of the character of estuaries.

The following table contains a list of all streams in the annexed district which can be distinctly traced.

facturing business, in proportion to the population, than Manhattan Island. This will result from the comparative cheapness of land, the more general distribution of railways, the superior and extensive water front, rendering great facilities for loading and unloading directly to or from cars or boats, and

a better street system, giving approximately minimum distances for haulage between given points. Manufacturers will be enabled at less cost to obtain larger premises, and in consequence the necessary floor-room, without having to erect high, strong and costly buildings, while the operatives will be able to obtain small houses and gardens close to their work.

We can foretell with a good deal of certainty where the manufacturing localities will be, the elements in the forecast being the value of the land, its elevation, its accessibility by rail and water, present occupation, water supply, sewerage, drainage, etc. Judging by the experience of other places, low, level swamps and marshes will be utilized in this way long before the better and more valued adjacent land will be in demand, although ultimately the choicer property will bring higher prices.

The sooner these swamps are drained the better, and, in providing for their drainage, it must be remembered that almost all factories use a large amount of water which is afterwards wasted in a highly polluted condition. Such waste water should never be allowed permanently to enter any of the fresh-water courses.

From the reports of the Massachusetts State Board of Health I gather the following statistics relative to the impurities to be found in the drainage from various kinds of manufactures:

Woolen Mills—Waste water polluted with nearly 5 per cent. of impurities, consisting principally of urine, dye stuffs, grease and dirt; also soap, fuller's earth, pigs' dung, pigs' blood, oil, alum, salt, soda and glue.

Cotton Mills—Waste water contains nearly one-tenth of 1 per cent. of impurities, including dye stuffs, cows' dung, starch, British gum, sulphuric and hydrochloric acids, soda ash, bleaching powders, lime, soap, metallic arsenic, etc.

Silk Mills—About three one-hundredths of 1 per cent. of solid matter in solution in refuse water. Some 40 pounds of soap are used for every 100 pounds of silk.

Bleach Works—Impurities, lime, soda, chloride of lime, sulphuric acid, etc., said to be slight, and copiously diluted. About five per cent. of weight of cotton yarn and sixteen per cent. of woven goods is removed in bleaching.

Linen and Jute Bleaching and Dyeing—Waste water contains about three-tenths of one per cent. of impurities.

Paper Mills—About five per cent. of impurities in refuse water of "boilings" and "washings," containing soda ash, caustic lime, alum, sulphuric acid, chloride of lime, etc. From six to sixty-three per cent. of weight of paper stock becomes liquid waste in manufacture of paper.

Rolling Mills—Waste water contains about one-tenth of one per cent. of impurities, due to manufacture.

Galvanizing Works—Waste water is small in quantity but contains over nine per cent of impurities, such as iron, chlorine, sulphuric acid, etc.

Brass Foundries—Drainage polluted with iron, copper, zinc chlorine, sulphuric acid, etc.

Breweries—No exact data can be obtained. It is claimed that the pollution of waste water is slight, although the odor is very offensive. Washing of casks estimated to consume twice as much water as the brewing. In malting 1½ per cent. of the grain is dissolved out in the steep-water.

Turkey Red Works—5,725 lbs. of garancine, sumach, blood, olive oil, alum, soda and soaps, recorded to have been used at one establishment for every ton of yarn or cloth in bleaching and dyeing. The waste water contains about $\frac{1}{10}$ of one per cent. of impurities, 3.2 per cent. of which is metallic arsenic.

The total capital invested in manufacturing in the Twenty-third and Twenty-fourth wards is estimated at over $2,754,000.

The value of the raw material annually consumed in manufacturing, $1,758,534.

The following table will exhibit the kind and local distribution of the principal manufactuting establishments, the aggregate power and labor employed therein, and the population of the various water sheds of the annexed district.

The product of the seven breweries, all draining into Mill Brook or Brook Avenue sewer, was, for the year ending 1st May, 1880, 5,931,890 gallons.*

Industry.	Water Sheds.										
	Hudson River.	Spuyten Duyvil.	Tibbet's Brook.	Cromwell's Creek.	Ice Pond Brook.	Mill Brook.	Harlem River.	Port Morris.	Bungay Creek.	Leggett's Creek.	Bronx River.
Breweries						7					
Brass Goods						1					
Boat-builder						1					
Chemical Works					2	1				1	
Carpet Weaving					1						
Curled Hair						1					
Carriage-maker				1		8				1	1
China Works									1		
Comb Works						1					
Dyeing						1					
Dye Works								2			
Drum Manufactory						1					
Electric Instruments and Burglar Alarm					2						
Foundries, Iron		1			2	1		1			
Foundries, Brass					1						
Flour Mill											1
Gas Works								1			1
Glucose Manufactory					1						
Gold Leaf Manufactory					1						
Kindling Wood					2						
Machine Shop					3	1					
Mineral Waters						2					
Musical Instruments						2					
Metal Works					1			1			1
Mouldings, Ornamental					2		1				
Macaroni Works					1						
Mat Factories					1						1
Piano Factories					1	2					
Pickle Works						1					
Pottery					1						
Paper Box					1						
Saw Mill			1								
Railings, Iron					1	1					
Rope Manufactories					1	1			2		
Sash and Blinds					2	1					
Stone Yards					4	1					2
Slaughter-houses						2					
Tool Works						1					
Tin Toys						1		1			
Tanneries						1					1
Tape Manufactory											1
Railway Car Works					1						
Varnish Works						1					
Vinegar Works						1					
Wood Turning						1					
Wagon Factory			1			1					

Water Sheds.	Average number of hands employed, exclusive of brewers.	Steam engines, aggregate horse-power, exclusive of breweries.	Value of material consumed, exclusive of breweries.	Capital invested, exclusive of breweries.	Population.
Hudson River	.....	.....	.....	.....	1,330
Spuyten Duyvil Creek	340	80	.....	.....	450
Tibbet's Brook	4	.....	.....	.....	1,281
Cromwell's Cr'k	.....	.....	.....	.....	1,792
Ice Pond Brook	584	314	$356,000.00	$477,000.00	8,357
Mill Brook	338	211	208,000.00	161,000.00	19,290
Harlem River	.....	.....	.....	.....	1,751
Port Morris	129	65	94,000.00	82,200.00	400
Bungay Creek	.....	.....	.....	.....	1,829
Leggett's Creek	5	2	.....	.....	1,725
Bronx River	356	.....	645,000.00	1,008,000.00	3,134

* For the above statistics, other than those relating to breweries and population, I am indebted to the courtesy of Hon. F. A. Walker, Superintendent Census, and Mr. Charles E. Hill, Chief Special Agent.

II.—THEORIES OF MALARIA.

Malaria seems to be the very general term for an unknown or indefinite poison, which, introduced into the human system (and sometimes it is claimed, even in domestic animals,) by means of breathing bad air or of drinking polluted water, produces a large class of distinctly recognized endemic diseases, as intermittent, remittent, pernicious fevers, etc., classified as "malarial or miasmatic fevers," also certain contagious diseases as typhoid fever, etc., classified as "miasmatic contagious." In the former class the morbific agent "miasm" is spontaneously developed exteriorly to the person affected, and in no case conveyed from the affected individual.

In the case of "miasmatic contagious" fevers the morbific agent is developed within and reproduced exterior to a physical organization. In the case of "contagious" fevers, such as small-pox, scarlatina and measles, the morbific agent is only developed and reproduced within a living being.*

In miasmatic contagious diseases the poison to be reproduced requires to be deposited in decaying organic matter. Clearly understanding this fact will explain why, in many cases, persons living in the midst of filth and with no sanitary precautions keep in good health. They are surrounded by most of the exact elements required for the reproduction of fevers, but until the specific poison has been added to the other elements no disease ensues. Some one has compared this state of things to that of an individual living over a powder magazine in perfect immunity from harm until a spark is added to the powder. Precisely in a similar manner imperfect sewerage and drainage are unsafe. Instances are on record where soil-pipes and drainage had been defective for a long time and yet no case of typhoid fever had resulted. When suddenly, however, it did break out, careful investigation showed that its development was preceded by the introduction of the excrement of a single person sick with the disease.

Even where the individual apparently escapes malarial diseases when exposed, all authorities are unanimous that the constitutional vigor is constantly taxed by its resistance to the poison, and is in a marked degree less able to resist exposure to and the effects of other diseases, such as diphtheria, dysentery, pneumonia, catarrhs, neuralgic and rheumatic affections, degenerative diseases, etc.

Dr. Loomis states that malaria predisposes to phthisical developments.

What the exact poison called malaria miasm, marsh miasm, etc., consists of, is far from being determined, the highest authorities being undecided and still differing.

Niemeyer says that it is not a product of decomposition, but that the decomposition of vegetable substances has an unmistakable influence on the development or excessive increase of this poison. He says, decidedly, that it consists of low vegetable organisms, whose development is chiefly due to the putrefaction of vegetable substances.

It is stated that M. Bolestra, in examining marsh water, always found, in proportion to its putrefaction, a granular microphite accompanied by a considerable quantity of small spores $\frac{1}{1000}$ of a millimeter in diameter, of a greenish yellow color and transparent, also by sporangia or vesicles containing spores from $\frac{1}{10}$ to $\frac{1}{100}$ of a millimeter in diameter and of very characteristic form. This plant grows on the surface of the water. When young it is iridescent and resembles spots of oil. At the low temperature of cellars, and in water containing no vegetation, it develops slowly, but in contact with air and exposed to solar rays it grows fast, disengaging small gas-bubbles. He thinks these spores constitute the poison miasm.

On the contrary, it has been asserted that the malarial poison is simply carbonic acid gas, that being the chief emanation from decomposing organic matter.

Liebig's theory seems to be that malaria is not a specific poison, but arises from the fact that stagnant water has oxygen taken from it by the putrefaction of organic substances, and hence kills all plants surrounded by it as it can impart no oxygen to their roots. These dead plants, in turn, putrify and vitiate the surrounding atmosphere by extracting oxygen from it, it being an established fact that putrefaction is a most powerful deoxidizing process.

Dr. Thompson believes that the malarial poison is a specific germ of organic nature which is mechanically diffused.

One theory is that malaria are in themselves simple agents always present in the atmosphere, but depending on certain meteorolgical influences to bring them into activity.

Another authority asserts that malaria are simple and perhaps well-known substances which are always present, but only act as poisons where there are certain modifications or predispositions of the body.

Again, others have believed that there are as many specific malarial agents as there are specific diseases.

Some have considered malaria to be matters of organic life, that is to say, invisible cells, germs, fungi, or animalcules, generated under favoring circumstances, caught up by the atmosphere and conveyed to man through the respiration, or communicated to him in the soluble form by inoculation.

"One sect assumes that the germs introduced into the living organism are actually multiplied there; others think that the poison, being organic primitively, does not necessarily act on the affected organism directly, but that coming in contact with decomposing matters in the soil it gives rise as a ferment to the formation of compounds which become poisonous when breathed—malaria."*

Dr. Richardson says, relative to malaria, that all zymotic diseases owe their symptoms not to the increase of the ferment but to new and determinate compounds generated in the blood by the presence of the ferment.

So much as to the nature of the poison itself. The theory of the necessary conditions for its production are less speculative and quite generally concurred in.

Dr. Loomis has very completely summarized these conditions as follows:

"1. A certain amount of vegetable matter: mat-

* Loomis on Fevers.

* Barker's "Malaria and Miasmata."

ter either on the surface or in the substance of the soil, where the malarial poison is generated. It is not necessary that the quantity be large, but a certain amount is necessary.

"2. A certain amount of moisture must be on the surface or in the substance of the soil; it need not be excessive, but some is indispensable.

"3. A certain average degree of temperature is necessary for its production. It cannot be developed below an average temperature of 58° F. for the 24 hours, and will not prevail as an epidemic unless the average temperature ranges as high as 65° F. for the 24 hours."

As to the local conditions for producing malaria, the same writer observes that—

1st. Marshes are especially favorable to the development of this poison, but all marshes are not malarial. The power to generate malarial poisons varies with the amount of water they contain. When there is an abundance of water malarial fevers are rare; when the marshes are covered only by a thin sheet of water, and are exposed to the direct rays of the sun, malarial poison will abound. Marshes that have dried up are especially favorable to the development of this poison, yet as soon as heavy rains submerge the previously parched surface the power to generate the poison is for a time diminished or entirely arrested.*

As a rule salt-water marshes are especially free from malaria, due greatly, no doubt, to the comparatively uniform humidity of the soil, the level of salt water being unaffected by drought. But when salt and fresh water become mixed, the most favorable conditions for its development exist. Niemeyer accounts for this last phenomenon, by explaining that the mixture of sea water with fresh water is peculiarly injurious, as many fresh and marine plants die and decompose in the mixture.

Marshes resting on a substratum of sand are far less malarial than those resting on limestone, clay or mud.

Marshes in high latitudes, which often during the heat of summer become dry, yet generate no malarial poison, although during the heat of the day the thermometer may reach 90° F., for the reason that the temperature during the night falls below 50° F.

Damp bottom lands subject to annual overflow are fruitful in generation of malarial poison.

2d. Another cause favoring development of malaria is the upheaval of new alluvial soils, such as obtain when new lands are first brought under cultivation, railroad excavations made, etc. Such excavations bring decomposing vegetable matters to the surface: these under the influence of heat and moisture generate miasm.

3d. Water flowing from malarial districts may bring malarial poison to non-malarial districts.

4th. Non-malarial regions may be rendered malarial from the poison transmitted by the wind. It may be carried up mountains from 600 to 1,000 feet.

Niemeyer observes that when marshes freeze, malarial fevers cease, the same being true when marses entirely dry up, or if the mouldering bottom of the marsh is protected by a thick layer of water from the action of the sun and air. Land uncultivated for some time and then tilled is apt to be malarious, and where malaria occurs over apparently dry soil it is due to sub-soil water.

MacCulloch says the essential character of all malarious marshes and swamps is, that the land should be partially inundated, that it should be dry in some places and wet in others, or that pools and dry spots should be intermixed, or that it should be boggy and soft from the mixture of earth and decayed vegetables with water, or that it should be subject to peculiar alternations of moisture and dryness.

Barker, in his treatise on malaria, states that the decomposition of vegetable matter, in other circumstances than in connection with soil, has frequently proved a prolific source of malaria. This is often exemplified by the very pernicious effects of steeping flax and hemp.† That there are many examples of fevers originating from the decomposition of coffee, potatoes and other vegetables, and that animal matter is not necessary to produce malaria; whether it increases the quantity, modifies the nature of the miasma is not known. Heat is the extrinsic agent most influential in favoring production of malaria, an influence attributable probably to the effect of a high temperature in favoring the chemical action between organized recrements and humidity, and likewise to its accelerating the formation of the aqueous vapors which appear to be the vehicle for the diffusion of the poison.

Sir Thomas Watson states that "for producing malaria, it appears to be requisite that there should be a surface capable of absorbing moisture, and that this surface should be flooded or soaked with water and then dried; the higher the temperature and the quicker this drying process the more plentiful and more virulent the poison that is evolved."

The foregoing notes on malaria are made somewhat full, because it will be noticed that while scientific investigators have yet failed to prove any one theory as to the exact nature of the specific poison called malaria, yet, with singular accord, they all admit the indispensable necessity of the presence of some form of stagnant water as one element in the evolution of malaria: so until the other elements of this poison are known equally beyond dispute, the only way to fight it is by eliminating this one certain element of stagnant water, or in a word by drainage.

THEORETICAL AND GENERAL CONSIDERATION OF SEWERAGE AND DRAINAGE.

It may be broadly stated that, other things being equal, the salubrity of any locality depends on maintaining the level of the water surface above the surface of the ground, or the plane of saturation below it, at a constant height.

Whatever the natural conditions of soil, climate, etc., may be, it will be observed that nature has invariably certain forms of organic life suited to just these conditions, and if these conditions remain constant the regular compensating transformation of inorganic matter to organic life, and of organic life back to inorganic matter, will be harmlessly maintained.

On the contrary, should these conditions be disturbed, the sudden destruction of these special forms of organic life must ensue and malarial poison be generated.

A swamp in which the same degree of saturation was constantly maintained would not be malarious. Except in the case of purely salt-water marshes, this condition is rarely met with in nature, and changes are frequently occurring: the natural sequence being: the overflow; a high degree of saturation of the soil, following the rains of spring; the growth of vegetation suited to this humid condition; the speedy lowering of the water by the droughts of summer; the consequent perishing of paludal vegetation; fermentation greatly accelerated by the alternating rains and heat of early autumn, producing malarial poison; finally, the stoppage of fermentation, and hence of malaria, by the frosts of winter.

Drainage helps to prevent malaria by tending to maintain at a constant height the plane of saturation of the soil. It is clearly proved that this is accomplished in two ways: first, by carrying off surplus water in wet season; second by rendering the soil so porous as to readily admit of the rising of moisture from greater depths to replace that evaporated from the surface in dry seasons.

The mere presence of water alone, is not malarious in effect. A sea voyage is indisputably without tendency that way; neither is the health of those living on the shores of our great lakes injuriously affected by their proximity to such vast bodies of fresh water.

Where water, from agitation, constant change, or great depth in itself, or certain depth below the surface of the soil, will not support organic growth, no harm need be apprehended from it.

There are two popular misconceptions regarding drainage; the first is the delusion that hiding wet ground by a light filling over it, is all that is required; the second, that drainage has to be carried to an excessive depth. The former is ineffectual, the latter is extravagant.

The mere covering of a swamp with a thin layer of dry earth will not alter the character of its vegetation, nor prevent fermentation in the water below the surface. I take it that the decay of the roots of plants is just as dangerous as that of their foliage under the same conditions.

On the other hand, all labor expended in lowering the water in the soil below a certain depth is lost, so far as to increasing the healthfulness of the locality.

The true plan is to drain the soil simply to a depth sufficient to prevent the premature decay of vegetation and consequent creation of ferment therein.

What the exact depth should be, of course, depends on the character of the soil; ordinarily the placing of drains four feet below the surface will accomplish this result

The practice of forming little fresh-water ponds, for ornament or use, should be prohibited, unless the source of supply is very constant and ample. Many country seats in this vicinity have fine lawns made by draining wet or swampy meadows, digging out some little hollow, allowing the drainage to collect therein, and thus forming a little pond. Generally these ponds are a blemish in landscape effect, and they are invariably a sanitary nuisance.

Although experts give conflicting testimony on the subject of flooding low lands during the winter for purposes of ice supply, the weight of evidence seems to be that the practice is dangerous to health. The bottoms of such temporary ponds are protected from frost all winter and saturated with water, so that not only is the growth of certain kinds of aquatic vegetation probable, but the spring vegetation will be rank and watery; in both cases to be followed by premature decay.

The depth at which drains should be placed below cellar floors need not be as great as that stated above; probably a foot and a half, or two feet, would be sufficient; the difference being that the cellar temperature is so much more equable than that of the open air that the fluctuations in the height of the plane of saturation of the soil will be diminished.

It is indispensable that the channels of all natural streams, if of any size and unceasing in flow, should be kept open by means of special drains. It may be possible to exterminate, so to speak, a natural stream by tapping its apparent sources of supply, conducting the water into the sewers, and then filling in the old channels; but the experiment would be a very hazardous one, every probability existing that the numerous exceedingly small secondary veins and channels, formed by years of natural drainage towards the brook, would still continue to act, thereby keeping saturated the new filling in the former brook channel.

It is generally quite unnecessary to build an independent drain for the entire length of the old channel. At convenient intervals the drain should be merged into some contiguous or intersecting sewer, and farther down on the line of the old channel a new drain commenced. (See Fig. 2.)

As a rule, drains should be trapped at junctions with sewers.

On no account should any drain, whether covered or open, be used as a sewer. Instances of fatal consequences, directly attributable to such perverted use, are on record, Salem and Wakefield, Mass., being examples.

Unless where they can be conducted through parks, it should be an invariable rule in cities to convert natural brooks into covered drains.

Dempsey, an authority on drainage, says that all drains depending simply on drainage for supply should be kept covered. In evidence taken in England, before a committee of Parliament, the fact was clearly elicited that covered drains will drain a greater breadth of land than drains of the same depth if left open.

There are several reasons for this: open drains are much more likely to become obstructed, out of repair, and covered with vegetation, and in some soils their sides become dry and plastered.

Again, the land over covered drains can be utilized, while that occupied by open ones must be wasted.

It is a certain result, in cities or their suburbs, that open drains become unsightly and the receptacle of all kinds of rubbish and filth.

A plan has sometimes been adopted, for suburban roadways, of having open, broad turfed gutters above for storm water, with covered drains beneath for ordinary flow.

Some theoretical persons insist on separate and complete systems of sewerage and drainage. The late Mr. Kirkwood, probably the leading authority in this country on practical hydraulics and drainage, says of such a system, that it has not found favor in this country, adding "nor are we aware that it has anywhere been found necessary."

It was customary, formerly, to lay the bottom of brick sewers *dry*—that is, without mortar—so as to allow for drainage from the ground into the sewer. This is not at all to be recommended: in times of drought the conditions will be reversed, the sewage escaping into the earth. Especially would this be dangerous where the sewer was built in dry, sandy soil, or where the street was an embankment and the bottom of the sewer above the original surface.

Sometimes the "inverts" of brick sewers are made of stoneware and cellular, thus forming a sub-way for drainage beneath the sewer.

The objection has been found to this arrangement that there was too little opportunity for the

* The result of observations at Munchen and Lyons leads Pettenkofer to state that when the *Grundwasser* is rising, typhus fever is decreasing, and the reverse occurs when it is lowering. By *Grundwasser* is not meant the level of underground water, but the saturation of the soil.

† *Urbs Vetus* in Italy was speedily and permanently freed from malaria by the Government preventing the rotting of flax near the town.

drainage water to enter, and too much for the sewage to escape.*

As stated before, all natural streams should be maintained as covered drains in cities; aside from these, no system of drainage is required in closely built portions, if the cellar drainage is properly arranged for.

Where houses are close together, and their cellars underdrained, the ground above the level of such cellar drains can never remain saturated. Again, where sewers have been constructed through streets their trenches act more or less as blind drains.

In fact the amount of water entering the ground in city streets is comparatively small. From careful experiments made in London, it was found in one densely built-up, well-sewered region, to be less than five and a half per cent. of the rainfall; on an average it was about twenty-five per cent., including amount evaporated from the pavement.

More attention should be give to the proper drainage of cellars in cities.

In a majority of cases cellars are not underdrained; the floors are concreted, and provision made for carrying into the sewer pipe any water that may find its way on to the cellar floor. This arrangement is defective, as the ground beneath the concrete may be saturated and the concrete not water tight; besides, the direct connection with the sewer pipe, although supposed to be trapped, will at times admit sewer gas, and if the sewer becomes choked the cellar will be flooded. In this arrangement the sewer pipe is generally carried beneath the cellar floor, instead of along the wall where it can be readily seen and repaired and much greater inclination given to it.

Instead of the above described arrangement I should recommend sub-draining cellar floors, for that purpose, making, at some convenient point in the cellar, a small well, say two feet in diameter and three or four feet deep. A system of tile pipe or broken stone drains should be laid under all parts of the cellar, arranged to discharge into this well. The well in turn should be kept free from any accumulation of water by means of a small pump, discharging into some sink or water-closet on the basement floor.

Where a water supply existed it might be easily arranged to utilize the water pressure to operate this small pump automatically, whenever water was being drawn.

With our present light on the subject of sewerage, the best plan for large cities situated near the sea, or on large tidal estuaries, is that known as the water carriage system; that is, the liquid portion of the sewage is used as a vehicle to carry by gravity the comparatively small amount of solid matter, a little over one-tenth of one per cent.

It is not a perfect system, and in theory is a wasteful one; yet incessant, costly and extensive experiments have so far failed to evolve anything more economical. The system is the safest in a sanitary point of view. The only proper way to deal with excrement is to carry it as fast and as far away from human dwellings as possible. It must be disposed of beyond the slightest doubt, so as to avoid being taken into the system.†

The most minute amount of typhoid excreta infecting water has been clearly demonstrated to have been the origin of severe and extensive epidemics of typhoid fever. The only sure way is to pour the sewage into vast bodies of salt water. Not over twelve hours should be allowed to elapse in its passage from the remotest house connection to the point where it reaches the outlet of the main sewer at tide water. I can see no probability of constructing any system of sewers in the annexed district where the time required for the above described transit of the sewage will occupy more than six hours. Fresh sewage is merely offensive, and does not give off dangerous gases until it begins to putrefy.

Very expensive and thorough researches have been made in England to determine the practicability of the utilization of sewage.

On the continent of Europe it is quite common to keep the flow from water-closets out of the sewers, and to use it with much advantage for agricultural purposes.

The necessary frequent removals, and even the short detentions before such removals, have made the process, wherever tried in England, exceedingly unpopular.

The sewage in our cities is so diluted that it can only be used for certain limited kinds of crops when disposed of by irrigation.

The solids, when precipitated chemically and mechanically, are all but worthless for manure, except when mixed with lime, or equally valuable foreign ingredients, to an unprofitable degree; while the fluid refuse is still far from being harmless.

The system of Captain Liernur has been much spoken of: it removes, by means of pneumatic pressure, the water-closet contents to reservoirs, where it is decanted in barrels for transport to farms. There is but little demand among the farmers for this barreled sewage, even in summer, and in winter it has to be dumped into the sea. In Paris the only sales which could be effected of prepared poudrette were at one-twentieth of its estimated value.

The Liernur system, although possessing many advantages, does not nearly equal the water-carriage system in economy and freedom from annoyance.

Over sixty different processes for purifying and deodorizing sewage have been experimented with. The results may be summed up by quoting the testimony of one of the English authorities: "The failure was, that they still left the sewage in so impure a state that the people on the river objected to the sewage being discharged into the river."

The filtration systems, that is, passing the sewage either up or down through filter beds of sand, charcoal, etc., have proved costly failures where experimented with in Birmingham.

The successes of all attempts to precipitate, by chemical processes the solid matter in sewage, to be used for manure, is summed up by Mr. Rawlinson, Chief Engineering Inspector to the Local Government Board, in a parliamentary report made in 1865:

"Experience, so far as carried, proves that fluid sewage cannot be manipulated into a solid manure so as to pay. There have been attempts at Leicester, at Tottenham, and for a time at Croydon. During the continuation and working of these sewage works there was the greatest possible nuisance, with no paying result. At Leicester the solid, which was expected to sell for four pounds per ton, could not be sold for four shillings per ton; at Birmingham the sewage sludge accumulated beyond the power to sell it for sixpence a ton.

"At Leamington there is an annual cost at the outlet works of some £400 to precipitate and remove the sludge from about one million gallons of sewage per day.

"At Cheltenham, Coventry, Worksop, and some other places, the separated sludge is sold at prices ranging from one shilling to two shillings per ton. In all these cases the fluid, the true sewage, is wasted."

Analyses show that the fluid refuse, which is wasted, contains more ammonia than did the original sewage.

The so-called lime process of precipitation, treating the sewage with fresh milk of lime, was so costly and created such a nuisance when tried in Birmingham, that its use was stopped by injunction.

The precipitation of sewage matter, by treatment with clay and sulphuric acid, known as the alumina process, is bound to be less effectual and more costly even than the lime process.

The "A. B. C. process" was at one time warmly advocated. Alumina, blood, clay, charcoal, etc., are employed to produce the precipitation of solid matter from sewage.

The Rivers Pollution Commission says of it: "The process produced no clearer water than what would have resulted if the sewage was allowed to settle by itself."

The foregoing are only a few of the many precipitating processes, but are enough to show the inexpediency of trying to utilize sewage by such means.

The irrigation process for disposing of sewage seems to be the only one promising success. It thoroughly purifies the offensive water and retains almost all the ammonia as a fertilizer. In brief, it consists in taking the dilute sewage just as it flows through the sewers, and carrying it to some point in the country where it can be used to sprinkle or flood the fields by an arterial system of tight pipes, or even open trenches; then, after percolating through the soil, the surplus water is carried off in a purified condition to the nearest water-course, by a system of tile or stone subdrains.

Where carefully and skillfully managed this system can be made a sanitary success, but I am aware of no instance where it has proved profitable financially.

English official authorities estimate the necessary size of the farms to provide for the disposal of sewage by irrigation to be 1 acre for every 80 to 150 inhabitants.

Taking the latter figure, we should require for the whole city of New York a sewage farm of about 80,000 acres, or for the annexed district, with merely its present population, about 300 acres. From all testimony the sewage farm at Croydon seems to be a model. It is 500 acres in extent, being about 1 acre for 120 inhabitants. By judicious management, giving more sewage to some kinds and less to others, vegetables in large variety are raised. The effluent drainage water is so pure as to be fit to drink. The net pecuniary result is, however, a small loss. The case of the Edinburgh sewage farm is the reverse of the above. They are described as thorough nuisances, being managed by private owners, who saturate the soil with the sewage, rendering it unfit for cultivation of other crops than grass.

A certain kind of grass, the Italian rye grass, seems best to flourish when irrigated with excessive amounts of sewage. Four or more crops of it are raised each year. Comparatively flat sandy land is required for sewage farms. Nothing suitable can be found about New York nearer than Long Island. In cold climates the process of irrigation is very much impeded or altogether stopped in winter.

The mistake made by almost all theorists on the subject of sewerage is the advocacy of one system under all circumstances.

There are those who reason that sewage contains fertilizing agents, hence should never be wasted; others, that it is dangerous and extravagant to try to utilize it at all.

Some there are who insist that no sewer should be smaller than will allow a man to pass through it, and that man-holes shall be close together. Directly opposed to this plan are those of a more recent school, who demand that no sewer shall be larger than will be half-filled at the hour of greatest ordinary flow, with only four or five man-holes per mile. Of course this latter system does not provide for the removal of storm water; there must be either a separate system of sewers for storm water or it must be allowed to find its way off over the surface of the ground.

Practically considered, there is no one system adapted to every situation; in each case a special study must be made of all local conditions before deciding what system of sewerage is best for any particular place.

The small-pipe system is particularly well adapted for villages and towns of a suburban character, while if applied to closely built-up cities it will prove quite inadequate. As stated before, where practicable, sewers should always discharge into large bodies of tidal water. Inland cities and towns should, as a rule, dispose of their sewage by irrigation. In some cases it might be permissible to waste the sewage in very large fresh-water rivers and lakes, but the practice is dangerous and cannot be recommended.

The fallacy of building large sewers in every case is readily exposed. The advocates of such a system reason that, where small sewers are found to *silt up*, it is because they are too small. In fact this is never the case. A sewer may be too small to accommodate the flow during heavy rains, yet, other things being equal, such sewer will keep cleaner than one which has twice the requisite capacity—the latter will get filled up with silt in much less than twice the time required by the smaller.

The actual time required to close the large sewer will be longer than for the small one, yet the rate of deposit will be much faster in the larger sewer. This fact it is which misleads generally.

The keeping a sewer from *silting up* is simply a question of maintaining a proper velocity of the current flowing through it. A velocity of two miles per hour will remove pieces of the heaviest stone; that of one mile per hour, pieces of brick, and that of three-quarters of a mile per hour, sand.

A sewer may have the proper inclination for producing the necessary velocity for moving sand when running full or half full, but if the size of the sewer be increased, the depth of current will be decreased, hence additional friction will result and the velocity be diminished.

For instance, suppose a pipe 1 ft. in diameter, running full of muddy water, to empty into another 4 ft. in diameter, both having the same rate of descent, the invariable consequence will be that the smaller pipe will keep clean, while mud will deposit in the larger one, and in general, for a given amount of flow, with a given head, the larger the sewer, the less the velocity.

Often the proper remedy for a sewer which tends to *silt up* is to make it smaller.

In designing a system of sewerage for new and partly built-up streets it is necessary to make the sewers of such size as will suit their future require-

* Recently a new form of stoneware "invert" has been made at some of the potteries, with which it is claimed that the floor of the sewer can be made perfectly tight, while the outer joints of this invert piece are comparatively open.

† Report Massachusetts State Board of Health, 1876.

ments, and of course larger than would be immediately necessary, so that at first the tendency is to *silt up.*

This can only be remedied by keeping them flushed. One of three courses must be taken; first, construct no sewer until the streets are fully built upon; second, build the sewers at first only large enough for present wants, and afterwards rebuild them; or, third, build the sewers at once large enough for ultimate use, and while little service is required keep them clean by flushing.

The value and economy of flushing sewers, to keep them clean, is not yet sufficiently appreciated in this country. In London, now the best sewered city in the world, it is carried on systematically. Any water supply which does not recognize the flushing of sewers as a necessary and legitimate use for water, is imperfect and behind the age.

III.—RECOMMENDATIONS.

Having presented in Part I. a brief description of the general physical and economic features of the Twenty-third and Twenty-fourth wards, and in Part II. a sketch of the various theories concerning the nature of malaria and its relations to drainage, we now have the necessary data on which to base practical recommendations for drainage.

This whole district is peculiarly well adapted by nature for economical drainage and sewerage. New York city as a whole is fortunately situated as regards these requisites, yet the annexed district presents fewer difficulties in the way of drainage than are met with on Manhattan Island.

While the cost of the sewerage on Manhattan Island has not been at all extravagant, in the annexed district it will be remarkable for its inexpensiveness, when compared with results, if comprehensive plans are matured at an early date and carried out systematically and steadily, not spasmodically or with speculative haste.

In this region the water feeding the swamps is not at all excessive, as it comes from no distant and grand source.

It is simply due to the rain falling over that particular district. This fact enables us to calculate with considerable exactness the maximum amount of drainage due from any swamp or locality.

Drainage as a public work should not embrace a complete and finished network of drains over all wet ground. It would certainly appear unjust to pay for such a system by the usual methods of assessment.

It seems to be well established by a recent decision of the Court of Appeals, that where the city constructs drains, it must first obtain a right of way, giving compensation to the owner whose land is occupied. Such right of way once acquired by the city would preclude the use of the land covered by it for any purpose that would prevent access to the drains for repairing and cleaning out.

This would be right and proper as far as lines of sewers and main drains were concerned, but would become an absurdity when applied to the ramifications of a complete system of small drains.

I am clearly of the opinion that it would not be proper for this Department to undertake to carry out such a system, any more than that the Police Department should be called upon to keep swept and clean the interior of all private dwellings.

Every one has the fullest liberty of keeping the interior of his premises in such degree of cleanliness or order as may suit his own ideas and inclinations, unless, in so doing, he interferes with or endangers the health or safety or liberty of the public.

If any citizen, living in an isolated house, allows the water to stand in his cellar, I can see no reason why this Department should construct a drain all the way to his cellar and then assess most of the expense on his neighbors.

As to the order of their construction, drains should be classified as follows:

First—Drains to be built when determined by this Department.

Second—Drains to be built when ordered by the Health Department.

Third—Drains to be built at the discretion of the property owners.

This Department would be fully occupied with and should only take upon itself the proper location and construction of main lines of drains, so as to come within reach of all properties requiring drainage.

The Health Department should compel property owners to build laterals and branches so as to remove all large swamps and pond-holes. The further drainage of the soil for agricultural and other purposes should be left to the owner, who is the only party to derive any benefit therefrom, and on whom the entire expense should fall.

One recommendation will apply to the whole district, and need not be repeated in the consideration of each separate water shed; it is, that in the construction of all streets and avenues great care should be taken at embankments to carry all water-courses (however small or irregular in flow) freely under the embankment, keeping as nearly as possible to their original lines, and afterwards being particularly careful to maintain them in good order and unobstructed.

Any one supposing that a system of drains or sewers can be constructed by human agency which, after completion, will never need further attention, will be as disappointed with results as the constructor of machines of perpetual motion.

Eternal vigilance is the price of safety, just as much with the hidden and artificial channels for drainage and sewerage as in matters politic.

No sewers, culverts or drains should ever be built in such manner, or form, as to preclude regular examinations and the comparatively easy removal of obstructions.

In concluding these general remarks I cannot refrain from calling your attention to a dangerous practice, which seems to be particularly common in the district under discussion. I refer to the introduction of a public water supply in streets long in advance of the building of sewers. A report of the Massachusetts State Board of Health states that a public water supply increases the amount of sewage from six to ten or more times.

Water pipes are laid at general expense; that is, paid for out of taxation; while the cost of sewers is assessed directly on the property benefited. As a consequence, the former are constantly being demanded by the most parsimonious, while the latter, as a rule, are not asked for, or are opposed in many cases. I venture to suggest, as a remedy, a plan which it is not too late to apply to the Twenty-third and Twenty-fourth wards; that is, to assimilate the methods of paying for these two analagous classes of improvements.

First, refund what few assessments have already been paid for sewers, and hereafter build all sewers in the district at public expense, charging an annual sewer rent for all connections made with them.

I now propose to take up for examination and recommendation as to drainage the different water sheds in succession, as follows:

1. THE HUDSON RIVER WATER SHED,

or so much of the same as lies within the annexed district.

This consists of some 569 acres, covering an area less than half a mile in average width, and about 2½ miles in length. About an average width of 1,000 feet next to the Hudson River is occupied by the river bank proper, rising quite abruptly toward the east, with a minimum inclination of 10 feet per 100 feet.

East of the river bank the rise is still very marked, although less steep, and much more broken and irregular.

At one point on the eastern boundary of this water shed, near Christ Church, Riverdale, an elevation of 282 feet above the river is attained, being the highest ground within city limits.

There are springs in this slope generally intermittent in flow, but no brooks or streams of any importance, the greater part of the rainfall of the water shed passing quickly to the river, in little torrents. Quite small areas of wet ground are in a few instances met with, but these can readily and best be drained by the owners of the property where they exist, who in all probability alone suffer any ill from allowing them to remain.

The only point which I can suggest as requiring public intervention is in regard to the water, more or less stagnant, to be found between the railroad embankment and the original shore of the river. I would recommend that all water courses, however small or intermittent in flow, be led directly into the river directly across the railroad, and that all ponds or basins between the railroad and former shore line be filled in so as to be at least as high as the railroad track. It is undisputed, I believe, that the east bank of the Hudson River was free from malaria until after the construction of the Hudson River Railroad, whereby large areas of what had formerly been part of the river were cut off and left as shallow ponds.

Three places require attention in this respect: One about 1,000 ft. north of Riverdale Station; another about 600 ft. south of the same; the third about 1,000 ft. north of Spuyten Duyvil Station.

2. SPUYTEN DUYVIL CREEK WATER SHED.

By this is understood that little district of 122 acres, situated at the very extremity of the Spuyten Duyvil Promontory where the drainage flows directly into the creek.

The characteristics of this district are much the same as those of the preceding one, except that the slopes are even steeper and more rocky.

I see no need of any public scheme of drainage being undertaken in advance of the regular sewerage of the district.

I should recommend that here, also, the bays and flats between the S. D. & P. M. R. R. and the old shore be filled in at least to the level of the railroad bank.

The small stream crossing Johnson avenue, River street and Kingsbridge road, is much polluted by sewage and garbage from the adjacent cottages, known as "Puddler's Row." I would recommend that the stream be converted into a covered drain for a portion of its length, and, if practicable, a sewer to be constructed to accommodate the houses now using the stream as a receptacle for filth.

3. TIBBET'S BROOK WATER SHED.

This large and important district, containing some 2,292 acres, presents nothing very intricate in the solution of the problem of drainage. The natural line of main drainage is very direct, occupying the axis of a well-marked valley, whose sides have slopes averaging from 3 to 6.5 ft. per hundred. The lines of the steepest slope are generally at right angles to the axis of the valley, hence the smaller streams flow very directly and rapidly into Tibbet's Brook.

My first recommendation touching this district would be in regard to the main drainage channel; that is, Tibbet's Brook. Some 1,300 acres of the water shed of this brook lie in Yonkers.

(TO BE CONTINUED.)

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 313.)

LIX.—NEW BEDFORD.

New Bedford, Massachusetts, is on the west side of the Acushnet River, in lat. 41° 38′ N., long. 70° 55′ W. Most of the city lies on a hill-side which ascends with an easy grade from tide water to a ridge of about 100 ft. elevation. The western slope of the city descends into the Tripp's Brook Valley. As a part of the town of Dartmouth it was settled about 1650. New Bedford was incorporated as a separate town in 1787, and in 1847 it was incorporated a city.

The first movement in relation to the introduction of water was made in 1860. From 1860 to 1865 various plans were discussed. In 1865, the plan of the works as hereinafter described having been adopted, the construction was begun, and water was introduced in 1869. Three commissioners were appointed by the City Council to act during the process of construction. At this time the population was 23,000.

Water is obtained from a storage reservoir of 300 acres area, and holding 400 million gallons, at 40 ft. above tide level, formed by a dam across the Acushnet River, about seven miles north of the centre of the city. The water-shed above the dam is 5 sq. miles.

The first dam was of earth, 600 ft. long, 25 ft. high and 20 ft. wide on top, with slopes of 2 to 1. The dam was built in a swamp with muck from 2 to 12 ft. deep, beneath which was hard pan from 1 to 3 ft. thick, overlying 20 to 30 ft. of fine sand, beneath which was rock.

A puddle wall in the centre was carried to hard pan, and in some cases 4 to 6 ft. below it. All muck was removed from under the upper slope of the dam. The upper slope was faced with a dry stone wall.

From the gate-house on the upper slope, a waste-culvert and conduit extended through the dam. They were founded on the fine sand. After the reservoir was filled in the summer of 1867, leaks began to appear below it. In February, 1869, a breach occurred, the gate-house and 100 ft. of the bank being swept away. W. J. McAlpine, C. E., reported that the failure was due to the fine sand

*Copyright 1881.

under the gate-house and culvert becoming saturated and running as quicksand. In rebuilding, this material was confined by two rows of battened sheet piling, 15 ft. apart. As rebuilt, the dam is 30 ft. wide on top, with slopes of 2 to 1. In the middle of the dam is a puddled wall, from 6 to 12 ft. in width. The inner slope is protected by a lining of large-size stone. A waste way is located at the east end of the dam, 50 ft. in width, constructed of rubble hydraulic masonry, except the overfall, which is hammer-dressed. The whole rests upon a timber and plank platform, and that upon a foundation of puddled earth. The gate chamber is located at the west end of the dam, and is carried out into the reservoir about 50 ft. The chamber is of hammer-dressed stone, laid in hydraulic cement mortar. The house is of brick, and the whole rests upon a timber and plank foundation.

From the dam the water flows by gravity for 5⅝ miles, with a descent of 0.58 ft. per mile through a single ring brick conduit, oviform, 3 × 4 ft.; the bottom being a semicircle of 3 ft. diameter. There are three overflows on this line of conduit for the discharge of surplus water.

The outlet of the conduit is into the receiving reservoir, which has a capacity of 3,000,000 gallons, a depth of 12 ft., and an elevation of 30 ft. above tide, with banks 12 ft. wide on top, with slopes of 2 to 1 outside, and 1½ to 1 inside. The inside slope has a lining of puddle 4 ft. wide at the top, and 10 ft. wide at the bottom of the reservoir and carried down 3 ft. below the bottom, and is protected by a lining of granite stone 1 ft. thick, having the joints well filled with fine gravel.

From the receiving reservoir the water is conducted 269 ft. in a stone culvert, to the pump well, which is 31 ft. long, 12 ft. wide and 17 ft. deep. There are four recesses, 5 × 6 ft., for the pumps.

From the pump well the water is raised 124 ft. to the distributing reservoir, 154 ft. above tide, through a 16-in. force main, 2,200 ft. long. The pipe system is also supplied in the lower section direct from the pumps, through a 10-in. main.

The distributing reservoir has a capacity of 15,000,000 gallons, 17 ft. deep. Its embankments are from 8 to 18 ft. above the natural surface of the ground. The top is 15 ft. in width, and its slopes are 2 to 1. On its inner slope is a lining of puddled earth 7 ft. wide at the top and 15 ft. wide at the bottom of the reservoir, and carried down 5 ft. below the bottom, covered with 12 in. of gravel, on which is laid a granite wall 18 in. thick at the bottom and 12 in. at the top.

There are two pumping engines. The larger engine, of 5 million gallons capacity, was designed by William J. McAlpine, C. E., and was built by the Quintard Iron Works, New York City. It is a vertical, beam, condensing engine, with two vertical single-acting pumps. Its general dimensions are: Steam cylinder, 38-in. diameter, 8-ft. stroke; beam, 26-ft. long; fly wheel, 16-ft. diameter and 12 tons weight. The pumps are placed one on each side of the beam centre, and are of 28-in. diameter and 56-in. stroke. The beam is supported by a cast-iron hollow column, which serves as an air chamber. The engine is supplied with the Sickles adjustable cut-off, and is capable of using steam expansively to any desirable extent. It passes slowly over the centres, thus giving the pump valves time to close. In the line of duty this engine has given excellent results. The smaller engine is a Worthington compound duplex engine, of a capacity of 3,000,000 gallons in 24 hours.

In 1873 a stand-pipe 5 ft. in diameter, and with its top 197 ft. above tide, was erected near the distributing reservoir.

The distributing pipes are partly of cast iron and partly of wrought iron, cement lined. There are 42 $\frac{37}{100}$ miles of pipe in use, ranging from 4 to 24 in. in diameter; of this length about 9½ miles are of wrought iron, cement lined, the rest being of cast iron.

There is also a large number of smaller distributing pipes ranging from 1 to 4 in.

In December, 1880, there were in use 295 fire hydrants, 3,798 taps, 22 meters and 14 motors.

The average daily consumption during 1880 was 2,014,200 gallons. The cost of the works to December 1, 1880, was $1,204,533.87. The total receipts have been $1,206,398.81. The bonded indebtedness is $700,000. The total receipts for the year 1880 were $39,644.48. The cost of management and repairs during that year was $14,483.07. The population in 1880 was 26,875.

The works are controlled by a board of five members, who report to the City Council.

Geo. A. Briggs, C. E., was chief engineer and superintendent from the commencement of the work until 1871, and William J. McAlpine, C. E., was consulting engineer during the construction. Since 1871 the superintendents have been as follows, viz.:

1871–72—Israel C. Cornish.
1872–77—George B. Wheeler.
1877–81—William B. Sherman.
1881 —Robert C. P. Coggeshall.

LX.—LAMBERTVILLE.

Lambertville, New Jersey, on the Delaware River, 14 miles above Trenton, is supplied with water by a private company. In 1878 the first works were built, taking water from a stream about a mile from the town, having a drainage area of about 1½ sq. miles, in a trap rock formation.

An old mill pond was cleared out, the old dam of large rip-rap tightened by sheet piling and puddling, and an outlet and waste pipe laid on rock and surrounded with masonry. The reservoir thus formed could be drawn down 12 ft., and held 1,814,640 gallons. The next year the dam was raised 4 ft., more than doubling the capacity of the reservoir. In 1880 the dam was raised 15 in., making the storage capacity 6,100,000 gallons.

A 10-in. pipe laid through the dam connects with an 8-in. main, which leads 5,327 ft. to the town. The reservoir surface is 246.35 ft. above tide level, or 165.75 ft. above the main street of the town.

In August, 1878, a Worthington pump of about 180,000 gallons capacity per day was placed near the river to pump water from it into the reservoir. This is used in very dry seasons only. Preparations are now making for the construction of a larger storage reservoir.

Cast-iron pipe is used in the distribution; 3.72 miles were in use in March, 1881, with 28 fire hydrants and about 50 taps. The company has a contract with the city to supply water for 28 fire hydrants for ten years at $500 per annum. The population is 4,300. The capital stock of the company is $12,500. The works cost about $20,000. The expenses for the two years ending Feb. 10, 1881, were $2,908.86, and the receipts $4,759.19.

Isaac M. Cassin, C. E., was consulting engineer during construction of the works. Martin Coryell, C. E., has been the engineer and superintendent from the beginning.

LXI.—LONDON.

London, in the province of Ontario, Canada, is at the junction of the north and south branches of the river Thames, and comprises an area of about 3 sq. miles. Settled in 1826, its population in 1878 was about 20,000, when water-works were constructed by the city after the plans and under the superintendence of Thomas H. Tracy, C. E. The supply is obtained from springs of very pure water, four miles from the city, and is lifted 200 ft. by two Worthington pumps of 3,000,000 gallons capacity, operated by two 72-in. Risdon turbine wheels working under 12 ft. head, obtained by a dam, 350 ft. long, across the Thames.

The reservoir, on the hill above the springs, has a capacity of 7,000,000 gallons, and is formed by an embankment on the east side of a natural depression. The inner slope is covered with 6 in. of tough puddled clay, overlaid with 6 in. of water-lime concrete and again with 2 ft. of puddled clay and 6 in. of gravel.

The main conduit to and through the centre of the city is 18-in. diameter, of cast iron tested to a pressure of 500 lbs. per sq. in., crossing over the river twice and under it once between the reservoir and city.

The distribution pipes are all of cast iron; 36 miles in length from 4 to 12 in. diameter.

There are 200 fire hydrants capable of throwing from each, four streams of water to a height of 40 ft. They were manufactured especially for the works after designs by T. H. Tracy, Esq., C. E.

The cost of works including interest to Dec. 31 1880, is $390,000. The works were all completed and 500 services laid to consumers within twelve months.

Two 2,000,000-gallon pumps operated by steam are now in course of construction as a reserve power in case of ice or spring freshets interfering with the turbine wheels.

The average daily consumption is about 1,250,000 gallons.

The works were built and are managed by a board of commissioners, composed of the mayor of the city and two citizens, elected by the people annually.

Thomas H. Tracy, who had the entire superintendence of the construction of the works, still retains the position of chief engineer, and is also city engineer. J. Danks is the secretary.

The commissioners purchased 74 acres of land in connection with the reservoir, which is used by the citizens for pleasure grounds.

LXII.—NEW ALBANY.

New Albany, Indiana, is on the north bank of the Ohio River, two miles below the Falls of 29 ft. in the river, which afford a valuable water-power, which has been largely utilized for manufacturing purposes. The city is built on two benches or plains, which slope gradually to the north from the river. It was laid out in 1813 and incorporated as a city in 1839. In 1875–6 water-works were built by a private company, after the plans and under the superintendence of Frank Schefold, C. E. Water is taken from the Ohio River. The 12-in. suction pipe of the pump is laid out into the river channel, with a strainer on its further end.

A single acting beam and fly wheel engine with 26-in. steam cylinder, working two plunger pumps of 16-in. diameter and 60-in. stroke placed 50 ft. below the engine floor, lifts the water 265 ft. through 4,800 ft. of 12-in. pipe into two reservoirs on a hill 192 ft. above the city, built in excavation and embankment, 16 ft. deep, and each of one and a half million gallons capacity. Another reservoir holding six million gallons has been built since the original construction of the works. The slopes are lined with 9 in. of brick laid in cement.

The distribution is by cast-iron pipes. The main from the reservoir is of 12-in. diameter. Sixteen miles of pipe are laid, of from 10 to 4-in. diameter. No accidents have occurred to the engine, reservoir or pipes since the works were built. There are 147 fire hydrants in use and 750 taps. The daily consumption is from 500,000 to 800,000 gallons. The population in 1880 was 16,422. The reservoir pressure is sufficient for fire purposes, and none of the three fire engines belonging to the city are used at all.

The cost of the works was about $200,000, and the annual revenue is about $25,000.

The "New Albany Water Works Company"

which built and manages the works has a capital stock of $100,000 and $100,000 of bonds were issued. Under a contract with the city the company was required to set 100 fire plugs at $100 each, and additional ones at $75 each, and to throw from the hydrants eight 1-in. streams simultaneously 100 ft. high. The contract test was complied with.

Frank Schefold, C.E., has been the engineer and superintendent from the beginning.

LXIII.—MONTGOMERY.

Montgomery, Alabama, in lat. 32° 23′ N, long. 86° 27′ W, is on a high bluff on the east bank of the Alabama River. Laid out in 1817, it was made the seat of the State government in 1847.

Water-works were built in 1873, by the Montgomery Water-Works Company, a corporation chartered by the Legislature of Alabama. The works, franchises, etc., were purchased at Chancery sale, July 1, 1880, by Geo. H. Hazlehurst and associates, who reorganized under the present style, "Montgomery Water-Works," with A. J. Lane, President and J. R. Baldwin, Secretary, Treasurer and Superintendent. The water supply is obtained from the Alabama River, pumping directly from the river, except in time of high or muddy water, when the supply is obtained from a filtering gallery, located in the gravel on the river bank. The pumps are Worthington duplex high pressure of nominal capacity of 1,000,000 gals. per 24 hours, which capacity is, however, largely exceeded in practice every day. Steam is supplied ordinarily by one battery of three boilers, each 44 in. × 32 ft. with double flues 15 in. diameter. A reserve battery of two smaller boilers is also used occasionally. Water is forced through a cast iron main 10 in. diameter 1¼ miles to a reservoir 184 ft. above mean low water in the river, and of an average elevation of 100 ft. above the business part of the town. The various branches leave the pumping main before it enters the reservoir, and in effect, when the pumps are in operation, the consumers are supplied directly from the pumps, the surplus going into the reservoir. This has a storage capacity of about 4,000,000 gallons, is an earth-work structure with outer slopes of 1½ to 1, and inner slopes of 2 to 1, with a promenade on top of the bank 20 ft. wide. There are ten miles of distributing pipes ranging from 10 in. to 3 in., all cast iron, supplying 103 fire hydrants and 550 private consumers. The population of the city in 1880 was 16,714. The city lies between the pumps and the reservoir. J. R. Baldwin is the superintendent.

LXIV.—NORTHAMPTON.

Northampton, Massachusetts, in lat. 42° 19′ N., long. 72° 42′ W., is on the Connecticut River. The main portion is situated on elevated ground, a mile from the river, with commanding eminences back of it. It was settled in 1654.

Water-works were built by the city in 1870–1, after the plans and under the superintendence of Nelson J. Welton and William W. Bonnet, civil engineers.

The supply is taken from Roberts' Meadow Brook, a mountain stream flowing through a rough granite region. Its drainage area is not known.

The water is impounded by an earth dam 17 ft. high at centre, with heart wall of puddle 12 ft. wide at foundation and 6ft. wide at top.

The upper slope is 2 to 1, and is paved with stone.

The waste-way was cut through an adjoining hill The earth banks washed to such an extent that they were lined with stone, the bank cut through to the bottom of the reservoir and a masonry overfall built.

On the upper slope of the dam is a brick gate chamber from which a 24-in. waste and a 16-in. supply pipe pass through the dam. The flow line is 240 ft. above the town.

The supply main passes through the villages of Leeds and Florence, which are supplied with water. From the reservoir to Florence, 14,471 ft., the pipe is 16 in. in diameter; from Florence to Northampton, 12,973 ft., it is 12 in. in diameter.

All pipes are of cast iron. In 1880, there were 22 miles of pipe and 125 hydrants. The population of Northampton in 1880 was 12,172.

The income had exceeded the expenditures and interest up to Feb. 1, 1880, by $3,085.11, and the entire cost of the works to the same date had been $209,322.84.

In 1875 the crossing of the 16-in. pipe under the Mill River was washed out by the disaster at the Williamsburg reservoir. During the relaying of the pipe a supply was had by a 10-in. pipe laid across a temporary bridge.

The works are managed by a Board of Water Commissioners. M. M. French was superintendent in 1873; in 1875 J. M. Clark was appointed, and is the present incumbent.

LXV.—COLUMBUS.

Columbus, Ohio, is in lat. 39° 57′ N., long. 83° 3′ W., on the Scioto River. The site is nearly level, and the city comprises 10.6 sq. miles. Founded in 1812, the water supply was from wells until 1870, when, its population being 31,274, the city built water-works, taking water from a well on the bank of the Olentangy River, a tributary of the Scioto.

In 1873-4 a brick conduit 370 ft. long, of elliptical form, 3×4 ft., 27 ft. below the surface of the ground and 13 ft. below the river was built from the well to filter basins. The lower basin was excavated to 13 ft. below the river, with slopes of 1 to 1, protected with rip-rap. The bottom area was 14,294 sq. ft. Its supply was drawn from the ground water and from the upper basin, of 8,742 sq. ft. surface, which was excavated to 7 ft. below low water in the river. Along the side of this basin adjoining the river and 7 ft. below the surface a gallery 18×21 in. was built, emptying into the lower basin. From it 14 smaller galleries radiated at 4.5 ft. below the surface, under the upper basin, the bottom of which was covered with graduated gravel and sand, the coarser stones at the bottom and 7 in. of fine sand on top. A 12-in. pipe admitted water from the river to this basin. The depth of water on the sand was 2.5 ft. at low stages of the river. This filtering arrangement soon proved to be of insufficient size. The basin, galleries and wells yielded about one million gallons per day, and the filter bed could not filter more than 500,000 gallons per day.

In 1877 to 1879 a natural filter gallery was extended along the river bank from the pumping works. The conduit is elliptical, 36 × 42 in., constructed of specially molded arch brick. Each alternate course of brick in the lower half has openings left in it to admit the ground water. The grade varies, but is generally about 23 ft. below the surface, or 10 ft. below low water in the river. Its construction was carried on in an open cut, through varying strata of alluvial deposit, quicksand and gravel. Except in good gravel the gallery is impervious to water. Its total length is 5,715 ft., passing under the Olentangy River, and at present terminating at a bend in the Scioto River, where a well with gates and inlet pipe allows water to be drawn from the river in emergencies.

Water is pumped directly into the mains by Holly engines.

The first pumping machinery consisted of a Holly 4-cylinder engine driving a set of "gang pumps" and rotary pumps.

In 1874 another Holly engine was erected with four 12-in. pumps, of a nominal capacity of 6,000,000 gallons per day, when working under 60 lbs. water pressure.

In 1876 the gang and rotary pumps were removed and a 4-cylinder double-action pump of 12 in. in diameter and 27-in. stroke was put in. These pumps are geared to a shaft driven by the engine of the former gang pumps.

The Scioto River is crossed by a 10-in. wrought-iron pipe 426 ft. long, with ball and socket joints. In 1873 an ice gorge formed in the river and broke the pipe in the middle of a section.

When relaid a trench 30 in. deep was dredged in the river bottom to receive the pipe.

The distribution is by cast-iron pipe, of which 39.5 miles were laid on March 31, 1880, 14 miles of them of 4-in. diameter. There were then in use 319 fire hydrants, 2,156 taps and 534 meters.

In 1880 the population was 51,665 and the daily consumption 2,159,327 gallons.

The cost of the works to March 31, 1880, including maintenance and repairs, was $884,867.27, and the total receipts had been $291,047.95.

The receipts for the year 1880 from water rents were $44, 572.47, and the cost of maintenance, $19,044.92.

The works are managed by a board of three trustees. C. M. Ridgway was superintendent for 1871–2. Frank Doherty has been superintendent since 1872.

LXVI.—MANKATO.

Mankato, Minnesota, is on the south bank of the Minnesota River, 86 miles from St. Paul. The business portion of the city is on a plateau about 30 ft. above ordinary stages of the river, back of which rise bluffs.

In 1875 a well 5 in. in diameter was sunk 2,200 ft. on the bluff, at a cost of $15,000. The water rose to within 80 ft. of the surface. An attempt was made to pump it to the surface, but the project was soon abandoned.

In 1879 R. D. Hubbard & Co. proposed to pump all the water needed by the city for fire protection, flushing gutters and street sprinkling for twenty-five hundred dollars per annum, and also what would be used by private takers at actual cost of pumping, the water to be taken from the Minnesota River, where it would necessarily be impregnated for a portion of the year with the city sewage. This offer was accepted, and fifteen thousand dollars in bonds issued for laying mains. Plans and specifications were prepared by M. B. Haynes, City Engineer, and a contract was made.

The contractors furnished and laid 58 ft. of 12-in. pipe, 1,933 ft. of 10-in. pipe, 1,705 ft. of 8-in. pipe, 5,400 ft. of 6-in. pipe and 4,965 ft. of 4-in. pipe, and also placed 30 hydrants. R. D. Hubbard & Co. had previously agreed to lay 467 ft. of 12-in. conduit pipe and erect a temporary crib at the river bank. Water is pumped directly into the mains by one Knowles pump, 12-in. water cylinder, 24-in. stroke and capable of throwing 1,200 gallons per minute. Total cost of the works to the city was $16,047.67.

The water is used to a limited extent by private takers. The works are under the care of the city engineer, supervised by a committee of the Common Council. A constant pressure of 40 pounds is maintained, and this, upon alarm, is instantly increased to fire pressure.

The present system is regarded as temporary.

(TO BE CONTINUED.)

Readers will please make the following corrections:

Aug. 6, p. 311, *Terre Haute*, second sentence, for *above*, read *a town*; fourth paragraph, for *Clapp & Sons*, read *Clapp & Jones*.

P. 312. *Kalamazoo*, fourth paragraph, for *Astell's*, read *Axtell's*.

P. 313, last column, for *Phineas Ball*, read *Phinehas Ball*.

We acknowledge the receipt of the following: From E.C.Boynton, Supt. Newburgh, N. Y., Water Works, 11th, 12th, 13th, 14th and 15th Annual Reports of the Board of Water Commissioners.; from John

B. Quigley, Supt. Trenton, N. J., Water Works, Annual Reports Board of Water Commissioners for 1879, 1880; from John Turner, Chairman Water Works Department, Marshalltown, Ia., 1st Annual Report Water Works Committee and 4th Annual Report Water Works Department; from R. C. P. Coggeshall, Supt. New Bedford, Mass., Water Works, written description of works and Annual Reports of Acushnet Water Board for 1870-71-72, 1875-6-7-8-9-80; from J. Danks, Sec'y and Manager of Water Works, London, Ont., written description of Water Works; from J. R. Baldwin, Supt. Water Works, Montgomery, Ala., written description of Water Works; from B. W. Reynolds, Supt. Water Works, Evansville, Ind., report on contract trials of pumping engine; from Frank Schefold, Supt. and Engineer New Albany Water Works, description of New Albany, Ind., Water Works; from E. H. Keating, City Engineer Halifax, N. S., Board of Works, report for 1880; from W. W. Bennett, C. E., tenth to fourteenth reports of Water Commissioners of Waterbury, Conn., 1877 to 1881.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

Water-works extension is going on at St. Thomas, Canada.

The artesian well at the Elgin watch factory is now down 1,185 ft.

The new water-works engine now being built by H. R. Worthington for the city of Cleveland, Ohio, will probably be in running order by November 1.

A dispatch from Peterboro, Ontario, says the ratepayers will be shortly called on to vote on a project to aid a water-works company by 50 per cent. of $40,000 stock.

The artesian well at the works of the Fayette Coke & Furnace Company, at Oliphants, Pa., has proved a grand success. At the depth of 200 ft. a flow of water sufficient to fill a 10-in. pipe has been obtained.

The lower reservoir at the water-works, Pittsfield, Mass., has been thoroughly cleaned for the summer. Superintendent Hatch finds the water supply getting short, and consumers will have to be economical. New double-stemmed hydrants to replace the old ones are being set on West street.

The water-works trustees of Youngstown, O., have awarded the contract for furnishing the many water pipes and special castings needed in extending the works to the Lake Shore Foundry, of Cleveland, at $31.60 per ton, and R. D. Wood & Co., of Philadelphia, got the contract for furnishing the fire hydrants at from $40 to $50 each, according to size.—*Cleveland Herald.*

On Wednesday of week before last the McKeesport water committee closed a contract with R. D. Wood & Co., of Philadelphia, to construct their water-works at a cost of $83,000. The contract for laying the pipes was sublet to Eichbach & Foster, of Philadelphia, and the boilers to Walter Jarbal, of this city. In addition to the work specified by the committee, Wood & Co. offer to build the stone wall at the pump-house and place an iron fence around the reservoir.

Water Superintendent Bush, of Westfield, Mass., has been wrestling for three or four days with a break in the water main where it crosses the Westfield River. A coffer-dam was built to get at the leak, but proved of no avail, and was abandoned yesterday, with lots of verbal structures of similar sound. Nothing further will be done until Sunday, when the mill-pond is to be drawn off, lowering the river so that the workmen can get at the pipe. The break causes little lowering of the pressure, and even people who use water-motors have hardly noticed any diminution in the speed of their machines because of it.—*Springfield Republican, Aug. 5.*

A Chicago dispatch says: "The warm weather has caused a scarcity of water in Hyde Park and Lake, and some complaint has been made of the too free use of the precious liquid by the South Park. Commissioner Cornell was seen to-day, and he said that the park was using very little water. It had shut down its fountain and was only using it for watering the vegetation and the streets. The later could also be given up if life depended on it. He thought, however, that reports had been greatly exaggerated, and that there was not a very deficient supply except in the south and west part of the towns, where there was a deficient water service."

ELECTRICITY.

Boston's electric lights went out suddenly Wednesday evening, leaving the city in almost total darkness. The main pulley, a five-feet wheel, broke down, and the engine had to be stopped. The gas men are said to be on a broad grin.

One of the chief hindrances to telegraphing in Japan is the grounding of the current by spider lines. The trees bordering the highways swarm with spiders, which spin their webs everywhere between the earth, wires, posts, insulators, and trees. When the spider webs are covered with heavy dews they become good conductors, and run the messages to earth. The only way to remove the difficulty is by employing men to sweep the wires with brushes of bamboo; but as the spiders are more numerous and persistent than the brush users the difficulty remains always a serious one.—*Scientific American.*

BRIDGES.

The Hartford & Connecticut Western Railroad finishes rebuilding and repairing its bridges this season. Fifty more coal cars are to be bought and 17 miles more of steel rails laid.

So far $12,884,437.23 have been expended on the Brooklyn bridge, and the managers are asking for $1,000,000 more, to complete the bridge at once.

Messrs. Clark, Reeves & Co., of Phœnixville, have just received an order from the Oregon Navigation Company for a single track draw, 330 ft., over Snake River, in addition to a lot of small orders for the Great Western Railroad and Mexican National Construction Company. They also closed a contract for 26 spans, aggregating 3,800 ft. of bridging, with a total weight of 1,700 tons of iron, costing in the neighborhood of $175,000, for the Galveston, Harrisburg & San Antonio Railroad in Texas.

We have received the following note from the Central Bridge Works, of 52 Wall street, this city, and Buffalo, N. Y.:

DEAR SIR: We have secured the extensive bridge works here (formerly owned by the late Kellogg Bridge Company), and having greatly improved the same are now prepared to furnish iron, steel or combination bridges, viaducts, roofs or other structures of the most approved designs and workmanship at minimum rates. With a thoroughly scientific knowledge of the business in all its details, many years of practical experience, ample means and close connection with the best manufacturers of iron and steel, we can always insure satisfactory result. Very truly yours,

CENTRAL BRIDGE WORKS.

RAILROADS.

The Denver & Rio Grande Railway completed its extension to Gunnison City Saturday. The line was opened for business to-day.

The last spike of the Baltimore & Cumberland Valley Railroad, between Waynesboro and Chambersburg, was driven on Thursday afternoon last.

The final survey of the Toronto and Ottawa Railway from Perth westward is now being made. The road is to be finished in two years, and is to be built in a first-class manner throughout.

Shumway, Burgess & Co., Chicago, have recently taken the contract for 200 tons of bolts to be used in connection with the new cable system of the Chicago City Railway Company.

The Connotton Valley Railroad engineer corps has reached Adamsville, ten miles north of Zanesville. This line is destined to connect Cleveland with the great coal and ore fields of the Muskingum and Hocking valleys.

The Iowa Eastern Narrow Gauge Railroad Company has been merged into a new organization, to be known as the McGregor & Des Moines Railroad Company, with headquarters at McGregor. The Iowa Eastern track will be extended to Elkader immediately.

Work has been resumed on the Anderson, Lebanon & St. Louis road, in the west part of Hamilton County, Ind. It must be finished soon, or lose the last installment of tax. President Lee is confident that the entire line will soon be under contract for its completion.

There seems to be an epidemic of railroad building in this State. There never was a time when so much construction work was being done, or so many lines projected. It is to be hoped that the whole will yield good results.—*Indianapolis Times.*

The Boston, Hoosac Tunnel & Western management have been concluded to double track the road, the bridges and culverts having been built for two tracks when the road was constructed. A large force of men are now engaged in different places along the line widening the cuts and road-bed.

The Peoria & Farmington Railway Company, which has succeeded the B. M. & I. R. R. (N. G.), will extend from Peoria, Ill., to Ruthburg, Ill., and be completed as a standard gauge railway, with maximum grades of 50 feet to the mile. All grades and curves on the main line are reduced 0.1 of a foot for each degree of curvature. The first 30 miles from Peoria is graded and bridged ready for the steel, and the balance of the line will be graded and bridged by November 1, 1881. The chief engineer is John F. Wallace.

A La Crosse dispatch says: "The contract for the bridging, piling, trussing and all other timber work on the Chippewa Valley & Lake Superior Railroad and Red Cedar branch to Red Cedar Falls has been let, and work will be commenced at once. There are to be three bridges across the Chippewa, and it is probable the value of the work will not be less than $100,000. It is probable that the Mississippi will be crossed by a winter bridge immediately upon the close of navigation, in order to connect with the river division at or near Wabasha."

The New York, Chicago & St. Louis Railway, which is to extend from Buffalo to Chicago, parallel with the Lake Shore & Michigan Southern, is being vigorously pushed. It is under contract its entire length, and work is in active progress at over forty different points. Entrance to Chicago will be effected through Hyde Park, where the Illinois Central will be joined. In this connection it may be mentioned that the Chicago & Atlantic, which the Erie is building from Marion to Chicago, will enter the city over the Chicago & Western Indiana. Upon the completion of these roads Chicago will have two more through east and west lines.

Improvements on the northern division of the St. Paul, Minneapolis & Manitoba road are reported to be rapidly progressing. Steel rails have been laid from Barnsville to Rolette, and from Crookston to Euclid, and the whole length of the line will be similarly treated as fact as the rails can be laid. Bridges have been built between Glyndon and St. Vincent, and piles are being driven for more in all low spots along the road, indicated by last year's freshets. These bridges are considerably higher than the road and the intention is to fill the road up level with them. A gravel train is now at work levelling up the track, and four gravel trains will be put on soon and the road ballasted from Crookston to St. Vincent.

RIVERS AND HARBORS.

The harbor and land commissioners have contracted with the New England Dredging Company to dredge 900,000 cubic yards of material from Boston harbor, to be used in filling part of South Boston flats. The whole cost will be over $500,000.

NEW PROJECTS.

The Long District Electric Call Company, with a capital stock of $50,000, was incorporated on the 8th. The trustees for the first year are James N. Jameson, William C. Lockwood, James Brady and Alfred P. W. Leman.

The New York Locomotive Works, with its place of operation at Rome, Oneida County, and a capital stock of $200,000, was incorporated on the 8th. T. G. Nock, D. B. Prince, Thomas H. Stryker, W. J. P. Kingsley, Edward Comstock, William W. Wardwell, William B. Isham, John W. Ellis and Henry A. V. Post are the incorporators.

The Highland Junction Railroad Company was incorporated Aug. 8, by filing its certificate with the Secretary of State. The road will commence at Matteawan and proceed thence across the Hudson River at Storm King to the Cornwall station on the Newburgh branch of the New York, Lake Erie & Western Railroad, the whole distance being about 10 miles. The capital stock is $1,000,000.

The St. Louis, Fort Smith and Southern Railroad Company, lately incorporated in Arkansas, has a capital of $2,500,000. The road will commence at or near the city of Fort Smith, in Sebastian County, Ark., and proceed thence southwardly in and through the counties of Sebastian, Logan, Scott, Polk, Howard, Sevier and Little River, to a point on the Red River somewhere in the vicinity of Texarkana, or possibly to that place.

The New York, Chicago & St. Louis Railroad Company has filed articles of incorporation with the Illinois Secretary of State; capital stock, $4,000,000. It is proposed to construct a line of road from a point in Vermilion county, running thence through the counties of Vermilion, Champaign, Edgar, Douglas, Coles, Moultrie, Shelby, Christian, Montgomery, Fayette, Bond, Macoupin, Madison and St. Clair to East St. Louis. Incorporators and first Board of Directors: Malcom Peters, of Philadelphia; W. H. A. Brown, Samuel H. Austin, Jacob M. Duncan and Frank Bierce, of Chicago, and George B. Easton, of Louisville, Ky.

CONTRACTING, MISCELLANEOUS, ETC.

The stone contract for the projected lock No. 8, on the Monongahela, has been let to Shipman & Carmody, for $46,326.00.

The Union Pacific elevator at Omaha will be completed some time in September, and will be the largest grain elevator in the West, having a storing capacity of 1,500,000 bushels. Grain will be cleaned in this elevator at the rate of 8,000 bushels per hour.

Mr. E. A. Pew, Vice-President of the Manitoba & Southwestern Railroad, has completed here the purchase and shipment of sufficient steel rails for fifty miles of road. Grading to this extent is to be finished during September, and trains are expected to run during November.

It is said that the iron and steel works now being erected at Goehen, Rockbridge County, Va., on the Chesapeake & Ohio Railroad, will be the largest in the South. The company, which is composed altogether of English capitalists, is styled the "Iron and Steel Works Association of Virginia." Mr. W. N. Page, of Virginia, is the superintendent of construction. The company has a capital stock of several million dollars. Two furnaces with capacity for a hundred tons a day each will be built, and also a large rolling mill and steel works.

The report of the Secretary of the American Iron and Steel Association, for 1880, shows that 4,295,000 tons of pig iron produced in the United States 1,839,000 tons of rolled iron, excluding rails; 955,000 tons of Bessemer and steel rails; and 494,000 tons of other rails. The production of all kinds of steel was 1,397,000 tons. The imports of iron and steel were $80,488,000: exports, $12,961,000. Imports of iron ore, 493,000 tons; imports steel blooms, 65,000 tons; production of Lake Superior iron ore, 1,987,000 tons; production of anthracite coal, 23,437,000 tons; production of bituminous coal, 43,000,000 tons.